A Contribution to the Phenomenological Theory of Kinetic Processes in Ferromagnetic Dielectrics. I. The Relaxation in the Gas of the Spin Waves SOV/56-34-6-30/51

Akhiyezer, L. D. Landau and I. M. Lifshits for useful advice and also V. G. Bar'yakhtar and S. V. Peletminskiy for profitable discussions. There are 9 references, 6 of which are Soviet.

ASSOCIATION: Fiziko-tekhnicheskiy institut Akademii nauk Ukrainskoy SSR (Physics and Technical Institute, AS UkrSSR)

SUBMITTED: March 22, 1958

Card 3/3

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SOV/56-35-2-23/60

24(6)

AUTHORS: Kaganov, M. I., Tsukernik, V. M.

TITLE: The Influence of Thermoelectric Forces on the Skin Effect in Metal (Vliyaniye termoelektricheskikh sil na skin-effekt v metalle)

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1958, Vol 35, Nr 2, pp 474-478 (USSR)

ABSTRACT: Formulae are deduced for the surface resistance in consideration of thermoelectric forces. The following system of equations serves as a basis:

$$\operatorname{curl} \vec{H} = \frac{4}{c}\vec{j};\ \operatorname{curl}\vec{E} = -\frac{1}{c}\frac{d\vec{H}}{dt};\ C\frac{\partial\theta}{\partial t} + \operatorname{div}\vec{q} = 0;$$

$$E_i = \rho_{ik} j_k + \alpha_{ik}\,\partial\theta/\partial x_k;\ q_i = T\alpha_k j_k - \varkappa_{ik}\,\partial\theta/\partial x_k$$

where $\Theta$ is the high-frequency addition to the average temperature $T$ of the sample, $C$ - the specific heat of the metal, $\vec{q}$ the heat current, $\varkappa_{ik}$ - the resistance tensor, $\rho_{ik}$ - the thermal conductivity tensor, and $\alpha_{ik}$ - the tensor of the thermoelectrical coefficients. $(\alpha_{ik} = \alpha_{ki})$.

Card 1/2

SOV/56-35-2-23/60

The Influence of Thermoelectric Forces on the Skin Effect in Metal

For the surface impedance it holds that $\zeta_x = E_x(0)/H_y(0)$ and $\zeta_y = -E_y(0)/H_x(0)$; $\zeta_x = \zeta_{ox} = \sqrt{\omega\sigma_{xx}/4\pi i} = \sqrt{\omega\sigma_{\perp}/4\pi i}$; $(\sigma_{\perp} = \sigma_{22} = \sigma_{33};\ \sigma_{11} = \sigma_{\parallel})$ and $\zeta_y$ is decomposed into $\zeta_y^{ad}$ and $\zeta_y^{isoth}$, for which equations are deduced as well. In the case of isotropy $\zeta = 1/\sqrt{\varepsilon - \sin^2\varphi}$ and $\zeta^{isoth} = \sqrt{\varepsilon - \sin^2\varphi}/\varepsilon$ is obtained, and for $\zeta^{ad}$ a considerably more complicated expression is found, the first term of which is equal to the expression for $\zeta^{isoth}$. In conclusion, the authors express their gratitude to L. D. Landau for his valuable discussions. There are 2 references, 2 of which are Soviet.

ASSOCIATION: Fiziko-tekhnicheskiy institut Akademii nauk UkrSSR (Physico-Technical Institute, AS UkrSSR)

SUBMITTED: March 26, 1958

Card 2/2

TSUKERNIK, V.M.

24(0) SOV/30-59-2-42/60

AUTHOR: Khalatnikov, I. M., Doctor of Physical and Mathematical Sciences

TITLE: Investigations of Low-temperature Physics (Issledovaniya po fizike nizkikh temperatur)

PERIODICAL: Vestnik Akademii nauk SSSR, 1959, Nr 2, pp 98-100 (USSR)

ABSTRACT: The 5th All-Union Conference on this problem took place in Tbilisi from October 27 to November 1, 1958. It was attended by physicists from Moscow, Khar'kov, Leningrad, Tbilisi, Sverdlovsk, and Kiyev. 4 fields of low-temperature physics were discussed: superliquidity of liquid helium II, supraconductivity, antiferromagnetism, magneto-resistive effect. The following reports and communications were heard: A. A. Abrikosov, L. P. Gor'kov reported on the investigation of the properties of supraconductive alloys. A. A. Abrikosov, L. P. Gor'kov, I. M. Khalatnikov spoke of properties of supraconductors in the high-frequency magnetic field. D. V. Shirkov and Chen' Chun'-yan' and Chzhou Si-shin', two young Chinese scientists working at Moscow University, described investigations for determination of the influence exercised by the Coulomb (Kulon) interaction of charges on supraconductivity. V. V. Tolmachev explained the

Card 1/4

nature of the so-called collective excitations of the Bose type in supraconductors. D. N. Zubarev, Yu. A. Tserkovnikov spoke of the thermodynamics of supraconductors and B. T. Geylikman, V. Z. Kresin of the thermal conduction of supraconductors. Yu. V. Sharvin, V. F. Gantmakher reported on experimental work with supraconductors. N. V. Zavaritskiy spoke of the measurement of the anisotropy of thermal conductivity in the supraconductive state. In a series of reports problems of the superliquidity of helium were discussed, which was discovered in 1938 by P. L. Kapitsa and the theory of which was set up in 1941 by L. D. Landau. E. L. Andronikashvili and his collaborators investigated the properties of rotating helium. V. P. Peshkov spoke of the effect of the formation of the boundary between superliquid and non superliquid helium. Guan Vey-yan', collaborator of the Institut fizicheskikh problem (Institute of Physical Problems) investigated the properties of the so-called jump in temperature of Kapitsa. I. M. Lifshits, V. G. Peschanskiy investigated galvanomagnetic phenomena in strong magnetic fields for metals with open Fermi surfaces. N. Ye. Alekseyevskiy, Yu. P. Gaydukov experimentally investigated the resistance anisotropy of gold monocrystals in the

Card 2/4

magnetic field. L. S. Kan, B. G. Lazarev combine the presence of a temperature minimum with the structural state of the metal. M. Ya. Azbel' reported on the quantum theory of metallic conductivity in the alternating electromagnetic and constant magnetic field. A. S. Borovik-Romanov reported on the weak ferromagnetism in antiferromagnetic samples of $MnCO_3$. N. M. Kreynes, Ye. A. Turov investigated the magnetic anisotropy of the antiferromagnetic monocrystals $CuSO_4$ and $CoSO_4$. R. A. Alikhanov reported on neutronographic investigations of antiferromagnetics. Ya. I. Kondorskiy and collaborators reported on the susceptibility of nickel and nickel-copper alloys at low temperatures. M. I. Kaganov, V. M. Tsukernik reported on kinetic phenomena in ferromagnetics at low temperatures. A. I. Akhiyezer, V. G. Bar'yakhtar, and S. P. Peletminskiy spoke of computations of the relaxation of the magnetic moment in ferromagnetic dielectrics at low temperatures. T. I. Sanadze spoke of observation results of paramagnetic resonance of terbium in the $TbNO_3 \cdot 6H_2O$ nitrate. G. R. Khutsishvili gave a theoretical analysis of the orientation of the nuclear spin in the Overhauser (Overkhauser)

Card 3/4

effect in nonmetals. B. N. Samoylov, V. M. Reynov and collaborators reported on obtaining orientated nuclei. N. F. Bulatova, V. S. Kogan and B. G. Lazarev showed that hydrogen isotopes in solid state have different structures. I. A. Gindin, B. G. Lazarev, Kh. D. Starodubov and V. I. Khotkevich detected polymorphism in a number of metals at low temperatures. E. L. Andronikashvili, V. P. Peshkov and M. P. Malkov reported on the stage of development of foreign scientific research work in the field of low-temperature physics. At the end of the Conference P. L. Kapitsa spoke of his successful development of investigations in the field of low-temperature physics. The participants of the Conference visited the Institut fiziki Akademii nauk Gruzinskoy SSR (Physics Institute of the Academy of Sciences of the Gruzinskaya SSR) and the Physics Faculty of Tbilisi University as well as the building of the new research atomic reactor near Tbilisi.

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24(3) SOV/56-36-1-30/62

AUTHORS: Kaganov, M. I., Tsukernik, V. M.

TITLE: On the Phenomenological Theory of the Kinetic Processes in Ferromagnetic Dielectrics (K fenomenologicheskoy teorii kineticheskikh protsessov v ferromagnitnykh dielektrikakh) II. The Interaction of Spin Waves With Phonons (II. Vzaimodeystviye spinovykh voln s fononami)

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1959, Vol 36, Nr 1, pp 224-232 (USSR)

ABSTRACT: The spin waves have to be described by the vector of the density of the magnetic moment $\vec{M} = \vec{M}(\vec{r}, t)$ by the deformation tensor $u_{ik} = (1/2)(\partial u_i/\partial x_k + \partial u_k/\partial x_i)$ where $u = u(\vec{r}, t)$ denotes the vector of displacement. In this case, the interaction Hamiltonian will be the sum of all components in the expansion of the energy of the ferromagnetic with respect to the powers of $M_i$, $\partial M_i/\partial x_k$, and $u_{ik}$: $\gamma_{iklm}\int M_i M_k u_{lm}\,dv$, $\lambda_{iklmrs} = \int \frac{\partial M_i}{\partial x_k}\frac{\partial M_l}{\partial x_m} u_{rs}\,dv$. The first of these terms corresponds to the energy of magnetostriction. The interaction Hamiltonian

Card 1/3

On the Phenomenological Theory of the Kinetic Processes in Ferromagnetic Dielectrics. II. The Interaction of Spin Waves With Phonons

SOV/56-36-1-30/62

is written down as $H_{interaction} = H_{magnetostriction} + H_{exchange}$,

where $H_{interaction} = \gamma \int M_i M_k u_{ik} dv$,

$$H_{exchange} = \lambda_1 \int \frac{\partial M_l}{\partial x_i} \frac{\partial M_l}{\partial x_k} u_{ik} dv + \lambda_2 \int \frac{\partial M_l}{\partial x_i} \frac{\partial M_l}{\partial x_i} u_{kk} dv.$$

In the second part of the paper the production and the absorption of phonons by spin waves are calculated. The authors also investigate the energy transfer from spin waves to phonons. The spin waves and the phonons are described by equilibrium distribution functions of the Bose (Boze) type for different temperatures. The coefficient of heat transfer for the activation process of the emission and absorption of phonons decreases exponentially with temperature. The third part of the present paper deals with the annihilation of 2 spin waves with production of a phonon and with the decay of a phonon into 2 spin waves. These processes are due to the magnetostriction part of the Hamiltonian. Practically at any temperature above $\mu$Mo, production and absorption of phonons

Card 2/3

On the Phenomenological Theory of the Kinetic Processes in Ferromagnetic Dielectrics. II. The Interaction of Spin Waves With Phonons SOV/56-36-1-30/62

play the most important part among the one-phonon processes. The two-photon processes are described by the square terms of the expansion of the energy of the ferromagnetic with respect to the powers of the deformation tensor. There are 2 types of such processes: scattering of a phonon on a spin wave (or vice versa) and emission (or absorption) of 2 phonons by a spin wave. Finally, the time necessary for the establishment of equilibrium (relaxation time) between spin waves and phonons is calculated. There are 5 Soviet references.

ASSOCIATION: Fiziko-tekhnicheskiy institut Akademii nauk Ukrainskoy SSR (Physico-Technical Institute of the Academy of Sciences, Ukrainskaya SSR)

SUBMITTED: July 8, 1958

Card 3/3

24 (3)

AUTHORS: Kaganov, M. I., Tsukernik, V. M. SOV/56-37-3-35/62

TITLE: Nonresonance Absorption of the Energy of a Variable Magnetic Field by a Ferromagnetic Dielectrics

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1959, Vol 37, Nr 3 (9), pp 823-832 (USSR)

ABSTRACT: A ferromagnetic substance may absorb the energy of a variable magnetic field in various ways: either the magnetic field (the amplitude of which is to be small, $H' \sim e^{-i\omega t}$) is polarized perpendicular to the equilibrium magnetic moment, in which case the magnetic field turns the moment without changing its value, or the field is polarized in the direction of the moment, in which case a superposed magnetization occurs, i.e. the absolute value of the magnetic moment is varied. In both cases dissipative processes are caused, which are interrelated with the interaction of spin waves, both among themselves, and also with phonons (it is assumed that the dielectric substance is magnetized up to saturation). In the present paper the authors confine their attention to those in which the variable magnetic field (frequency $\omega$) is polarized in the direction of the

Card 1/4

Nonresonance Absorption of the Energy of a Variable Magnetic Field by a Ferromagnetic Dielectrics SOV/56-37-3-35/62

equilibrium moment. Calculation of absorption is then reduced to calculation of the imaginary part of longitudinal magnetic susceptibility $\mu_{\parallel} = \mu'_{\parallel} + i\mu''_{\parallel}$. The complex character of the relaxation processes in ferromagnetic dielectrics leads to a complex frequency dependence $\mu''_{\parallel}(\omega)$. The authors proceed from the simple model, in which the ferrodielectric body is considered to have a magnetic moment, the vibrations of which propagate in form of spin waves. This is justified at sufficiently low temperatures, when the vibrations of one of the magnetic sublattices are not excited by the others. The theory of spin waves may be applied to real bodies, e.g. to ferrites the semiconductor properties of which at low temperatures are insignificant (the number of free electrons with decreasing temperature tends exponentially towards zero). The first part of this paper deals with the low frequency range, i.e. $\omega$ is much smaller than the reciprocal spin-spin relaxation time $\tau_{ss}$: $\omega\tau_{ss} \ll 1$. The following is obtained for the imaginary part of the longitudinal magnetic susceptibility after all frequency- and temperature ranges have been dealt with in detail:

Card 2/4

Nonresonance Absorption of the Energy of a Variable Magnetic Field by a Ferromagnetic Dielectrics

SOV/56-37-3-35/62

$$\mu'' \sim \begin{cases} \frac{M_o\mu}{\theta_c}\left(\frac{T}{\theta_c}\right)^{1/2} \frac{\omega\tau_{sl}}{1+\omega^2\tau_{sl}^2}, & \omega\sqrt{\tau_{sl}\tau_{ss}} \ll 1, \quad T \ll T_o \\ \frac{\mu M_o}{\theta_c}\left(\frac{T}{\theta_c}\right)^{1/2} \frac{\omega\tau_{ss}}{1+\omega^2\tau_{ss}^2}, & \omega\sqrt{\tau_{sl}\tau_{ss}} \gg 1, \quad T \ll T_o \\ \frac{\hbar\omega}{\mu M_o} \frac{1+\omega^2\tau_2^2}{(1+\omega^2\tau_1^2)^2 + \omega^2\tau_3^2}, & \omega\tau_{ss} \ll 1, \quad T \gg T_o \end{cases}$$

Here $T_o \sim \mu M_o(\theta_c/\mu M_o)^{3/7}$, $\tau_{sl}$ denotes the spin-lattice relaxation time. The second part deals with high frequencies ($\omega \gg 1/\tau_{ss}$), the Hamiltonian of the interaction between field and spin being set up according to Kaganov (Ref 2): $\mathcal{H}_{int} = \mu\int \hat{H}_z\hat{a}^*(\vec{r})\hat{a}(\vec{r})dv$. If $\omega$ tends towards $\infty$, then magnetic susceptibility tends towards unity, and its imaginary part towards zero. For the frequency dependence of $\mu''$ at very high

Card 3/4

Nonresonance Absorption of the Energy of a Variable Magnetic Field by a Ferromagnetic Dielectrics SOV/56-37-3-35/62

frequencies it holds that $\mu'' \approx \frac{8\sqrt{2}}{15} \frac{\mu^2}{a^3} \frac{(2\pi\mu M_0)^2}{\theta_c^{3/2}(\hbar\omega)^{3/2}}$,

$\left(\hbar\omega \gg \frac{\hbar}{\tau_{ss}}, T, \mu H_{eff}\right)$. Thus, $\mu''$ decreases inversely proportionally with $\omega^{3/2}$ and is independent of temperature. The authors thank V. G. Bar'yakhtar for valuable discussions. There are 10 Soviet references.

ASSOCIATION: Fiziko-tekhnicheskiy institut Akademii nauk Ukrainskoy SSR (Physico-technical Institute of the Academy of Sciences, Ukrainskaya SSR)

SUBMITTED: April 18, 1959

V. M. Tsukernik

21(0) SOV/53-67-4-7/7

AUTHOR: Chentsov, R.

TITLE: The Fifth All-Union Conference on the Physics of Low Temperatures (5-ye Vsesoyuznoye soveshchaniye po fizike nizkikh temperatur)

PERIODICAL: Uspekhi fizicheskikh nauk, 1959, Vol 67, Nr 4, pp 743-750 (USSR)

ABSTRACT: This Conference took place from October 27 to November 1 at Tbilisi; it was organized by the Otdeleniye fiziko-matematicheskikh nauk Akademii nauk SSSR (Department of Physico-mathematical Sciences of the Academy of Sciences, USSR), the Akademiya nauk Gruzinskoy SSR (Academy of Sciences, Gruzinskaya SSR), and the Tbilisskiy gosudarstvennyy universitet im. Stalina (Tbilisi State University imeni Stalin). The Conference was attended by about 300 specialists from Tbilisi, Moscow, Khar'kov, Kiyev, Leningrad, Sverdlovsk, and other cities as well as by a number of young Chinese scientists at present working in the USSR. About 50 lectures were delivered which were divided according to research fields.

III. Galvanomagnetic Phenomena. (10 lectures). I. M. Lifshits and V. D. Peschanskiy (KhFTI, Khar'kov Physico-technical Institute, Khar'kov University) showed that the most important part in connection with the galvanomagnetic properties of metals is played by the concrete form of the Fermi surface of conductivity electrons. N. Ye. Alekseyevskiy (IFP) spoke about experiments he carried out together with Yu. P. Gaydukov. He investigated the variation of the resistance in the transversal magnetic field at helium temperatures of Au, Cu, Pb, Ta, Ga, Ni and (together with V. I. Kostina) of Bi. Ye. S. Borovik and V. G. Volotskaya (KhFTI) investigated the galvanomagnetic properties at low temperatures of chromium and zirconium and found that the resistance of chromium grows with field strength without attaing a saturation value. L. S. Kan and B. G. Lazarev (KhFTI)

Card 5/11

investigated the resistance minimum in gold at low temperatures and found that if the sample is heated, the minimum disappears. Yu. P. Gaydukov (IFP) said in this connection in the course of the discussion that the minimum effect does not occur in gold in the case of very pure samples; the disappearance of the minimum is explained by the plastic deformation of the sample at helium temperatures. M. Ya. Azbel' (KhFTI) gave a report of his work in connection with the quantum theory of the high-frequency resistance of metal in a constant magnetic field at low temperatures. M. I. Kaganov and V. M. Tsukernik (KhFTI) spoke about a theoretical investigation of the influence exercised by thermoelectric forces upon the skin effect in various conductors. B. I. Verkin and B. N. Aleksandrov (KhFTI) spoke about measurements of the electric resistance of thin wires made from highly-pure tin, indium and cadmium, and computed the free length of path at 4.2°K in these metals as amounting to 1/3 to 2/3 mm. N. B. Brandt (MGU) and B. I. Verkin and I. M. Dmitrenko (KhFTI) investigated the influence exercised by the hydrostatic pressure (of 1000 atmospheres absolute pressure) upon the behavior of metals at low temperatures and investigated

Card 6/11

the quantum oscillations of the magnetic susceptibility of bismuth at 1.6 - 4.2°K. G. Ye. Zil'berman and A. M. Kosevich (KhFTI) gave a theoretical explanation of the fact that already relatively small deformations exercise considerable influence upon oscillation effects in metals. IV. Magnetism. A. S. Borovik-Romanov (IFP) delivered a report on investigations he carried out of the anisotropy of the weak ferromagnetism in monocrystal samples of the antiferromagnetic $MnCO_3$ (the effect of anisotropy was predicted by the thermodynamical theory developed by Dzyaloshinskiy). In the course of the discussion R. A. Alikhanov (IFP) spoke about neutronographical investigations he carried out of the magnetic structure of $MnCO_3$ and $FeCO_3$ at low temperatures. P. L. Kapitsa stressed the importance of the method based upon Dzyaloshinskiy's theory. M. K. Zheynes (VNIIFTRI), whose lecture was read by A. S. Borovik-Romanov, reported on measurements carried out by him (in the IFP) of the magnetic anisotropy of the antiferromagnetic $CuSO_4$- and $CoSO_4$-monocrystals.

Card 7/11

Ye. A. Turov (IFM AN SSSR, Sverdlovsk) spoke about his theore-

17

V. M. TSUKERNIK

SOV/53-67-4-7/7

24(0)

AUTHOR: Chentsov, R.

TITLE: The Fifth All-Union Conference on the Physics of Low Temperatures (5-ye Vsesoyuznoye soveshchaniye po fizike nizkikh temperatur)

PERIODICAL: Uspekhi fizicheskikh nauk, 1959, Vol 67, Nr 4, pp 743-750 (USSR)

ABSTRACT: This Conference took place from October 27 to November 1 at Tbilisi; it was organized by the Otdeleniye fiziko-matemati-cheskikh nauk Akademii nauk SSSR (Department of Physico-mathematical Sciences of the Academy of Sciences, USSR), the Akademiya nauk Gruzinskoy SSR (Academy of Sciences, Gruzinskaya SSR), and the Tbilisskiy gosudarstvennyy uni-versitet im. Stalina (Tbilisi State University imeni Stalin). The Conference was attended by about 300 specialists from Tbilisi, Moscow, Khar'kov, Kiyev, Leningrad, Sverdlovsk, and other cities as well as by a number of young Chinese scientists at present working in the USSR. About 50 lectures were deliver-ed which were divided according to research fields. . . . IV. Magnetism.

A. S. Borovik-Romanov (IFP) delivered a report on investiga-tions he carried out of the anisotropy of the weak ferro-magnetism in monocrystal samples of the antiferromagnetic $MnCO_3$ (the effect of anisotropy was predicted by the thermo-dynamical theory developed by Dzyaloshinskiy). In the course of the discussion E. A. Alikhanov (IFP) spoke about neutrono-graphical investigations he carried out of the magnetic structure of $MnCO_3$ and $FeCO_3$ at low temperatures. P. L. Kapitsa stressed the importance of the method based upon Dzyaloshinskiy's theory. N. M. Kreynes (VNIIFTRI), whose lecture was read by A. S. Borovik-Romanov, reported on measure-ments carried out by him (in the IFP) of the magnetic aniso-tropy of the antiferromagnetic $CuSO_4$- and $CoSO_4$-monocrystals.

Card 7/11

Ye. A. Turov (IFM AN SSSR, Sverdlovsk) spoke about his theore-tical investigations of the magnetizability, the susceptibility, the specific heat, and the resonance frequencies of anti-ferromagnetics and weak ferromagnetics. A. I. Sudovtsev and Ye. Ye. Semenenko (KhFTI) spoke about measurements of the electric resistance of iron in magnetic fields in a wide tem-perature range with simultaneous plotting of the magnetization curve. N. V. Vol'kenshteyn, G. V. Fedorov, E. V. Galoshina and M. I. Turchinskaya (IFM AN SSSR) spoke about measurements of magnetization and the Hall effect of polycrystalline samples, nickel and $Ni_3Mn$ at low temperatures. Ye. I. Kondorskiy, V. Rode, U. Gofman and Chang, Shou-ch'un (MGU) gave a report on susceptibility measurements on nickel and its alloys with copper at low temperatures; T. I. Sanadze (TGU) spoke about the spectrum of the paramagnetic resonance of $Tb^{3+}$ in terbium nitrate at temperatures of liquid hydrogen. M. I. Kaganov and V. M. Tsukernik (KhFTI) dealt with the kinetic phenomena in ferromagnetics at low temperatures and with calculation of relaxation time; A. I. Akhiyezer, V. Bar'yakhtar and S. Polatsinskiy (KhFTI) carried out a theoretical investigation of the relaxation of the magnetic moment in ferrodielectrics; Vlasov (IFM AN SSSR) showed that a linearly polarized elastic

Card 8/11

(ultrasonic) wave of a frequency of $10^9$ cycles when passing through a ferromagnetic substance in the direction of the magnetic field, is subjected to a turn of the polarization plane of the order of $10^{-3}$ - $10^{-4}$ radian/cm oersted. M. I. Kaganov pointed out that in this connection yet another phenomenon may be observed, namely the resonance absorption of ultrasonics if the wavelength is equal to the radius of the Larmor orbit of the electron. . V. Various Questions. One of the most interesting lectu-

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24.2200 (1385,1144,1162)

AUTHORS: Kaganov, M.I., Tsukernik, V.M. and Chupis, I.Ye.

TITLE: Theory of Relaxation Processes in Antiferromagnetics

PERIODICAL: Fizika metallov i metallovedeniye, 1960, Vol.10, No.5, pp.797-798

TEXT: The method put forward by Akhiyezer (Ref.1) and Kaganov and Tsukernik (Ref.2) is used to calculate the mean probabilities of processes associated with the interaction between spin waves in ferromagnetics. The theory holds in the temperature region

$$\Theta_c \left(\frac{\mu_0 M_0}{\Theta_c}\right)^{1/2} \ll T \ll \Theta_c$$

in which the energy of the spin wave is given by the well-known expression

$$\varepsilon_\lambda = \Theta_c (ak_\lambda)$$

Card 1/3

85974

S/126/60/010/005/029/030
E032/E414

Theory of Relaxation Processes in Antiferromagnetics

The notation is defined in the previous paper by the present authors (Ref.3). The processes considered are: (a) combination of two spin waves into one, and (b) collision of two spin waves. The probability of other processes, for example combination of three spin waves into one, have zero probability since energy and momentum conservation laws cannot be satisfied at the same time. It is found that the mean probabilities for the above two processes are respectively given by

$$\bar{W}_3 \approx \frac{\Theta_c}{h}\left(\frac{\mu_o M_o}{\Theta_c}\right)^{5/2} \frac{T}{\Theta_c}^{3} \qquad (3)$$

$$\bar{W}_4 \approx \frac{\Theta_c}{h}\left(\frac{T}{\Theta_c}\right)^{5} \qquad (4)$$

Comparison of these two probabilities shows that in the above

Card 2/3

85974
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E032/E414

Theory of Relaxation Processes in Antiferromagnetics

temperature region the non-homogeneous exchange interaction is responsible for setting up the thermodynamic equilibrium in a spin wave system. Acknowledgments are expressed to V.G.Bar'yakhtara for valuable discussions. There are 3 Soviet references.

ASSOCIATIONS: Fiziko-tekhnicheskiy institut AN USSR (Physical-Technical Institute AS UkrSSR)
Khar'kovskiy gosudarstvennyy universitet im. A.M.Gor'kogo (Khar'kov State University im. A.M.Gor'kiy)

SUBMITTED: April 18, 1960

Card 3/3

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S/056/60/038/004/036/048
B006/B056

9.4300 (1035,1138,1143)
24.7900

AUTHORS: Kaganov, M. I., Tsukernik, V. M.

TITLE: Nonresonance Absorption of the Energy of an Alternating Magnetic Field by a Ferromagnetic Dielectric. II

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1960, Vol. 38, No. 4, pp. 1320 - 1325

TEXT: In part I of the present paper, the nonresonance absorption of the energy of an alternating magnetic field by a ferromagnetic dielectric has already been investigated on the assumption that this field is polarized in the direction of the axis of easiest magnetization. The case is now dealt with, in which the field is polarized perpendicular to this axis. These two cases are described as longitudinal and transverse fields. Contrary to what is the case in a longitudinal field, energy absorption may occur in a transverse field even if no dissipative processes occur, but when the field frequency agrees with the ferromagnetic resonance frequency. Neither resonance nor the effects connected with it are considered. The results obtained here relate to frequencies

Card 1/3

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Nonresonance Absorption of the Energy of an Alternating Magnetic Field by a Ferromagnetic Dielectric. II

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that are distant from resonance. The dissipative processes connected with the energy absorption are caused by the interaction between the magnetic field and the spin waves. The authors assume (like in Ref. 1) that the ferromagnetic dielectric is magnetized up to saturation at a given temperature, i.e., that it may be considered to be a single-domain sample. The sample is also considered to be sufficiently pure, so that impurity effects may be neglected. It is shown that the nonresonance absorption of magnetic field energy is connected with the forming of two spin waves as a result of a "collision" between a photon and a spin wave. Besides, an absorption of the photon in higher perturbation-theoretical approximations is possible due to processes in which a large number of spin waves participate. The most important process in this case is one of the fifth order, which occurs in second perturbation-theoretical approximation. The coefficient of the absorption of magnetic field energy $\Gamma = Q\left(\frac{h_0^2}{8\pi} V\right)^{-1}$ is now investigated, where Q denotes the amount of energy absorbed per second within the entire sample volume.

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Card 2/3

83743

Nonresonance Absorption of the Energy of an Alternating Magnetic Field by a Ferromagnetic Dielectric. II

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One obtains $\Gamma = \frac{1}{32\pi^2}\frac{w^2T^2}{\mu M_o\Theta_c^3}\omega(1 - e^{-\hbar\omega/T})I(\eta,\nu)$, where $\eta = \mu H_e/T$ and $\nu = \hbar\omega/T$; the function $I(\eta,\nu)$ is represented as an integral equation by (13) and (13'). These equations are integrated for the special cases of low frequencies ($\nu \ll 1,\eta$), resonance frequency ($\nu = \eta$), and high frequencies ($1 \gg \nu \gg \eta$; $\nu \gg 1 \gg \eta$; $\eta \gg \nu \gg 1$; $\nu \gg \eta \gg 1$). The resulting asymptotic values of the integrals are used to determine approximate formulas for $\Gamma$ in the various special cases. The authors thank A. I. Akhiyezer and V. G. Bar'yakhtar for discussions. There are 3 references: 2 Soviet and 1 US.

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ASSOCIATION: Fiziko-tekhnicheskiy institut Akademii nauk Ukrainskoy SSR (Institute of Physics and Technology of the Academy of Sciences Ukrainskaya SSR)

SUBMITTED: November 23, 1959

Card 3/3

S/056/60/039/002/044/044
B006/B070

AUTHORS: Kaganov, M. I., Tsukernik, V. M.

TITLE: Theory of the Non-resonant Absorption of a Variable Magnetic Field by a Ferromagnetic Dielectric

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1960, Vol. 39, No. 2(8), p. 518

TEXT: In an earlier paper, the authors calculated the absorption coefficient of a variable magnetic field polarized perpendicular to the axis of easiest magnetization. The Hamiltonian used in that case took only the exchange interaction into account. Later, Tsukernik showed that in this case only resonance absorption of a homogeneous magnetic alternating field may take place, since the total magnetic moment commutes with the Hamiltonian of the system; the results of the earlier paper (Ref. 1) are therefore wrong. The error is related to the fact that in the calculation of the matrix elements of the transition, the authors restricted themselves to the first approximation of the perturbation theory. A consideration of the second approximation shows that the matrix

Card 1/2

Theory of the Non-resonant Absorption of a Variable Magnetic Field by a Ferromagnetic Dielectric

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B006/B070

element vanishes to the corresponding accuracy. The non-resonant absorption of the homogeneous field is related to the relativistic interactions in the system (dipole-dipole interaction, anisotropy energy, etc.). These problems will be considered in a later paper. Here, the authors give only a formula for the coefficient of absorption of a transverse magnetic field whose frequency is considerably smaller than that of the spin wave in the case of a zero quasi-momentum. The absorption described by this formula is due to a decay of a photon into two spin waves with oppositely directed quasi-momenta. There is 1 Soviet reference.

ASSOCIATION: Fiziko-tekhnicheskiy institut Akademii nauk Ukrainskoy SSR (Institute of Physics and Technology of the Academy of Sciences Ukrainskaya SSR)

SUBMITTED: July 2, 1960

Card 2/2

ACCESSION NR: AP4019844 S/0181/64/006/003/0818/0826

AUTHORS: Genkin, G. M.; Golubeva, N. G.; Tsukornik, V. M.

TITLE: The spin phonon width of lines of antiferromagnetic resonance

SOURCE: Fizika tverdogo tela, v. 6, no. 3, 1964, 818-826

TOPIC TAGS: spin phonon interaction, magnetic resonance, magnetization precession, exchange interaction, antiferromagnetism

ABSTRACT: The authors have examined the relaxation of the uniform precession of magnetization in a uniaxial antiferromagnetic as a consequence of interaction between spin waves and phonons (both acoustical and optical). They show that the relaxation processes of creating (or absorbing) an acoustical phonon by a spin wave, by virtue of the law of conservation of energy and momentum, may take place only at frequencies of

$$\omega_0 > \omega_0^{gr} = \frac{\sqrt{3h_A}\,v}{a},$$

where $\omega_0$ is the frequency of antiferromagnetic resonance, $h_A$ is the field of

Card 1/2

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ACCESSION NR: AP4019844

anisotropy, v the velocity of sound, and a the lattice constant. The interaction is an exchange process. The width of the line has been computed for any temperature. At rather high frequencies of antiferromagnetic resonance, $\omega_0 > \omega_0^{gr}$, where normally $\omega_0^{gr} \sim 2 \cdot 10^{12}$ sec$^{-1}$deg, the spin-phonon line width at low temperatures proves to be much greater than spin-spin line width. At frequencies of $\omega_0 < \omega_0^{gr}$, the spin-phonon width is small compared to spin-spin width, except for regions of very low temperatures ($T < 10^{-3}$K). Orig. art. has: 39 formulas.

ASSOCIATION: Radiofizicheskiy institut, Gorkiy (Radiophysical Institute)

SUBMITTED: 21Sep63 DATE ACQ: 31Mar64 ENCL: 00

SUB CODE: SS, EM NO REF SOV: 003 OTHER: 008

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30083
S/048/61/025/011/007/031
B108/B138

AUTHORS: Kaganov, M. I., and Tsukernik, V. M.

TITLE: Off-resonance absorption of a variable magnetic field by ferromagnetic dielectrics at low temperatures

PERIODICAL: Akademiya nauk SSSR. Izvestiya. Seriya fizicheskaya, v. 25, no. 11, 1961, 1346-1351

TEXT: The authors studied the absorption of an h.f. magnetic field whose plane of circular polarization is perpendicular to the equilibrium magnetic moment of the ferromagnetic. They consider absorption without resonance, which can only occur by the interaction of spin waves with one another and with phonons. The calculations are made for temperatures considerably below the Curie point $\Theta_c$. The absorption coefficient $\Gamma$ of the magnetic field is given as $\Gamma = \frac{8\pi\hbar\omega}{h_o^2 V}\sum\{W_{if} - W_{fi}\}$, where $W_{if}$ is the probability of direct, and $W_{fi}$ of inverse, transition. The absorption

Card 1/4

coefficient due to spin-spin interaction is evaluated for two limiting cases: (1) High temperatures $T \gg \varepsilon_0$ (but still $T \ll \Theta_c$):

$$\Gamma_{ss} \approx \begin{cases} A_1\omega\left(\frac{w}{\Theta_c}\right)^2 \frac{\mu M_1}{\Theta_c} \cdot \frac{\hbar\omega T^2}{\varepsilon_0^3}, & \hbar\omega \ll \varepsilon_0, \\ A_2 g M_0 \left(\frac{w}{\Theta_c}\right)^2 \frac{T^2}{\hbar\omega\Theta_c}, & \varepsilon_0 \ll \hbar\omega \ll T, \\ \frac{4}{15}\sqrt{\frac{\pi}{2}}\,\zeta(3/2)\, g M_0 \left(\frac{w}{\Theta_c}\right)^2 \frac{T^{5/2}}{(\hbar\omega)^{1/2}\,\Theta_c}, & \hbar\omega \gg T, \end{cases} \qquad (17)$$

where $w = \frac{\mu^2}{a^3}$ is the dipole-dipole interaction energy; $A_1 \sim A_2 \sim 10^3$.

(2) Low temperatures $(T \ll \varepsilon_0)$:

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$$\Gamma_{зз} \approx \begin{cases} B_1 \omega \left(\frac{w}{\theta_c}\right)^2 \frac{\mu M_0}{\theta_c} \frac{\hbar\omega T^{7/2}}{\varepsilon_0^{7/2}} e^{-\frac{3\varepsilon_0}{T}}, & \hbar\omega \ll \varepsilon_0, \\ \frac{4}{15}\sqrt{\frac{\pi}{2}}\, \omega \left(\frac{w}{\theta_c}\right)^2 \frac{\mu M_0}{\theta_c} \left(\frac{T}{\varepsilon_0}\right)^{7/2} e^{-\frac{3\varepsilon_0}{T}}, & \hbar\omega \gg \varepsilon_0, \end{cases} \quad (18)$$

where

$$B_1 = \frac{15\pi^{7/2}}{8\sqrt{2}} \left\{121 + \frac{1}{15}\left[\left(\frac{2\beta}{\pi} - \frac{2}{3}\right)^2 + \frac{121}{45}\right]\right\} + \frac{4}{15}\sqrt{\frac{\pi}{2}} \approx 10^4$$

$\varepsilon_0 = \mu H_0 + \beta\mu M_0$ where $H_0$ denotes the permanent magnetic field along the axis of easiest magnetization, $M_0$ the equilibrium magnetic moment, $\beta$ the anisotropy constant, a the lattice constant, $\mu = g\hbar$, g the gyromagnetic ratio. The results for spin-lattice interaction show that these contributions to the overall absorption coefficient are considerably smaller than the contribution due to spin-spin interaction. The considerations have been made for perfect ferromagnetics without

Card 3/4

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Off-resonance absorption of a...

impurities. I. M. Lifshits is thanked for discussions. This paper was read at the Conference on ferromagnetism and antiferromagnetism in Leningrad, May 5-11, 1961. There are 1 figure and 4 Soviet references.

ASSOCIATION: Fiziko-tekhnicheskiy institut Akademii nauk USSR (Physicotechnical Institute of the Academy of Sciences UkrSSR)

Card 4/4

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B108/B138

AUTHORS: Kaganov, M. I., and Tsukernik, V. M.

TITLE: An absorption mechanism for a longitudinal magnetic field by a ferromagnetic dielectric

PERIODICAL: Akademiya nauk SSSR. Izvestiya. Seriya fizicheskaya, v. 25, no. 11, 1961, 1352-1353

TEXT: The ferro-dielectric absorption of the energy of a variable magnetic field polarized along the axis of easiest magnetization was studied in detail in a previous paper (Ref. 1: Zh. eksperim. i teor. fiz., 37, 823 (1959)). The absorption of the field at $\omega\tau_{ss} \ll 1$, where $\tau_{ss}$ is relaxation time, was calculated with the aid of the kinetic equations for the distribution function of the spin waves. The calculations were made for temperatures T considerably below Curie point $\theta_c$. At high frequencies, absorption is chiefly determined by the disintegration of a photon into two spin waves with opposite momenta. This process was also considered in the above paper. It was pointed out, however, that a photon will only

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Card 1/4

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An absorption mechanism for a...

disintegrate into two spin waves at frequencies $\omega$ greater than $\frac{2\varepsilon_0}{\hbar}$, where $\varepsilon_0$ is the energy of a zero-momentum spin wave. The wide range $\frac{1}{\tau} \ll \omega < \frac{2\varepsilon_0}{\hbar}$ has not been considered as yet. Absorption in this range is the subject of the present paper. In the lowest spin-wave approximation, the Hamiltonian for spin wave interaction with one another and with a longitudinal magnetic field is $H' = H_{int} + H_h$ (1) where $H_{int} = \sum_{123} \Phi_{12;3} a_1^+ a_2^+ a_3$ + complex conjugate (2) and $H_h = \frac{1}{2} \mu h_o (e^{i\omega t} + e^{-i\omega t}) \sum_k a_k^+ a_k$ (2'). $h_o$ denotes the amplitude of the variable field. The other notations may be found in Ref. 2 (Akhiyezer A.I. et al., Uspekhi fiz. nauk, 71, 533 (1960)). In the approximation in question (second approximation in perturbation theory), strong exchange interaction does not contribute to absorption. It can be seen from the (1) and (2) that the transition matrix elements that are linear with respect to the variable field are nonvanishing only in second and higher perturbation-theoretical approximation. The corresponding lowest order processes are: (a) merging of a photon and a spin wave, which form two spin waves and (b) merging of two spin waves and one photon to form one spin wave. The

Card 2/4

30064 S/048/61/025/011/008/031
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calculation of the appropriate absorption coefficients $\Gamma_a$ and $\Gamma_b$ is similar to that given in detail in Ref. 3 (Kaganov M. I., Tsukernik V. M., present number of this periodical, p. 1346). In this article, only the final results for the total absorption coefficient $\Gamma = \Gamma_a + \Gamma_b$ are given, with precision up to a numerical factor of the order of unity. At high temperatures ($\varepsilon_0 \ll T \leqslant \theta_c$)

$$\Gamma \sim \begin{cases} gM_0 \dfrac{w^3}{\varepsilon_0 \theta_c} \left(\dfrac{T}{\theta_c}\right)^2, & \dfrac{\hbar}{\tau_{ss}} \ll \hbar\omega \ll \varepsilon_0, \\ gM_0 \dfrac{w^3}{\hbar\omega\theta_c} \left(\dfrac{T}{\theta_c}\right)^2, & \varepsilon_0 \ll \hbar\omega \ll T, \\ gM_0 \dfrac{w^3}{\theta_c^{1/2} (\hbar\omega)^{1/2}} \left(\dfrac{T}{\theta_c}\right)^{1/2}, & T \ll \hbar\omega \ll \theta_c. \end{cases}$$

At low temperatures ($T \ll \varepsilon_0$)

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An absorption mechanism for a...

$$\Gamma \sim \begin{cases} gM_0 \frac{w^2}{\theta_c^2}\left(\frac{\varepsilon_0}{\theta_c}\right)^{1/2}\left(\frac{T}{\theta_c}\right)^{1/2} e^{-\frac{3\varepsilon_0}{T}}, & \frac{\hbar}{\tau_{ss}} \ll \hbar\omega \ll \varepsilon_0, \\ gM_0 \frac{w^2}{\theta_c^{3/2}(\hbar\omega)^{1/2}}\left(\frac{T}{\theta_c}\right)^{1/2} e^{-\frac{\varepsilon_0}{T}}, & \hbar\omega \gg \varepsilon_0. \end{cases}$$

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Comparison of the results obtained with the absorption coefficient due to the disintegration of one photon into two spin waves (Ref. 1) shows that the processes considered in this paper are only effective at $\hbar\omega < 2\varepsilon_0$. [Abstracter's note: Complete translation.] This paper was read at the Conference on ferromagnetism and antiferromagnetism in Leningrad, May 5-11, 1961. There are 3 Soviet references.

ASSOCIATION: Fiziko-tekhnicheskiy institut Akademii nauk USSR (Physicotechnical Institute of the Academy of Sciences UkrSSR)

Card 4/4

26424
S/056/61/041/001/019/021
B102/B231

24.2200

AUTHORS: Kaganov, M. I., Tsukernik, V. M.

TITLE: High-frequency magnetic susceptibility of uniaxial ferromagnetic crystal in a longitudinal magnetic field

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 41, no. 1(7), 1961, 267 - 271

TEXT: Susceptibility dispersion of an antiferromagnetic material is mainly due to rotation of the magnetic moments of the sublattices in a magnetic field. The imaginary part of $\chi$ exhibits a resonance character in this case: resonance frequency coincides with the natural rotation frequencies of the system of moments. These frequencies have been computed for various equilibrium configurations by C. Kittel (Phys. Rev., 85, 329, 1952) and Ye. A. Turov (ZhETF, 34, 1009, 1958). In an earlier paper (ZhETF, 24, 524, 1958), the authors of the present work have computed the h-f susceptibility of a uniaxial antiferromagnetic body without magnetic field. If the magnetic field is strong enough, the equilibrium configuration of the sublattice moments may change, which

Card 1/7

would result in a change of the dispersion character. Starting from the Landau-Lifshits equations for the motion of the sublattice moments, the h-f susceptibility tensor of an antiferromagnetic body is computed for various values of the constant magnetic field strength, that is, for various equilibrium configurations of the moments. The results permit to draw conclusions from h-f measurements as to the equilibrium structures and the transitions between them. The uniaxial antiferromagnetic body is assumed to have two sublattices and to be positioned in a homogeneous, constant and in a weak and variable (frequency $\omega$) magnetic field. The motion of the moments due to field action is described by

$$\partial \mathbf{M}_s / \partial t = g\,[\mathbf{M}_s \mathbf{H}_e^{(s)}] - (\gamma / M^2)\,[\dot{\mathbf{M}}_s\,[\mathbf{M}_s \mathbf{H}_e]], \qquad (1),$$

where $\vec{M}_s$ is the magnetization vector of the s-th sublattice, M the sublattice magnetization which is assumed to be constant, g the gyromagnetic ratio, $\gamma$ the relaxation constant, $\vec{H}_e^{(s)}$ the effective field acting upon the s-th sublattice: $\vec{H}_e^{(s)} = -\partial \mathcal{H} / \partial \vec{M}_s$, where $\mathcal{H}$ stands for the energy density of the antiferromagnetic body:

26424
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B102/B231



$$\mathcal{H} = \alpha M_1 M_2 - \tfrac{1}{2}\chi\,[(M_1 n)^2 + (M_2 n)^2] + \eta\,(M_1 n)(M_2 n) - H\,(M_1 + M_2). \quad (3).$$

Here, $\alpha$ is the constant of exchange interaction ($\alpha > 0$), $\lambda$ and $\eta$ represent the anisotropy constants which are assumed to be positive; n is the unit vector in the direction of the axis of the antiferromagnetic body. Using the notation stated hereinafter: $H_1 = \sqrt{(\lambda+\eta)(2\alpha-\lambda+\eta)}\,M$, $H_2 = \sqrt{(\lambda+\eta)(2\alpha+\lambda+\eta)}\,M$, $H = H_3 = (2\alpha-\lambda+\eta)M$, and $H_4 = \left[\lambda(2\alpha-\lambda+\eta)^2/(2\alpha+\lambda+\eta)\right]^{1/2}M$ ($H_4 < H_1$; $H_2 - H_4$ is the width of the hysteresis loop of the antiferromagnetic body), the following cases are subjected to investigation: 1) $H < H_1$. $m_\pm$ is equal to $\chi_\pm h_\pm$, where $h_\pm = h_x \pm ih_y$, $m_\pm = m_x \pm im_y$, $\vec{h}$ stands for the h-f magnetic field, and $\vec{m}$ for the variable part of the entire magnetic moment. With

$$\Omega^2 = (g^2M^2 + \gamma^2)(\lambda+\eta)(2\alpha+\lambda+\eta) - \gamma^2H^2/M^2, \quad (5)$$
$$\Omega_1^2 = 2\,(g^2M^2 + \gamma^2)(\lambda+\eta),$$

Card 3/7

the following is obtained:

$$\chi_{\pm} = \frac{\Omega_1^2 - 2i\omega\gamma}{\Omega^2 - (\omega \mp gH)^2 - 2i\omega\gamma(\alpha + \lambda + \eta)}, \qquad \chi_{zz} = 0. \qquad (6).$$

The width of the antiferromagnetic resonance lines is thus given by $2\gamma(\alpha + \lambda + \eta)$. With H = 0 one has $\chi_+ = \chi_- = \chi_{xx} = \chi_{yy}$. 2) $H_1 < H < H_3$. Here, $\chi_{zz} \neq 0$, and the following is obtained:

$$\chi_{zz}(\omega) = \chi_{zz}(0)\frac{\nu^2 + i\nu\omega}{\nu^2 + \omega^2}; \qquad (7)$$

$$\chi_{zz}(0) = 2/(2\alpha - \lambda + \eta), \qquad (8)$$

$$\nu = (2\alpha - \lambda + \eta)\gamma \sin^2\theta = \gamma(1 - H^2/H_3^2)\,H_3/M.$$

From this, the following is obtained for the behavior of the relaxation time $\tau = 1/\nu$ in the vicinity of the point of second-kind phase transition (with $H \approx H_3$):

$\tau = \frac{1}{\gamma}\frac{MH_3}{H_3^2 - H^2}$. If T is fixed, and $H = H_3$ the following is valid:

High-frequency magnetic ...

$$\tau = \frac{G}{|T_K - T|}, \quad G = M/2\gamma \left|\frac{dH_3}{dT}\right|_{T=T_K} \qquad (8''),$$

where $T_k$ is the temperature of phase transition. This means that with the frequency being fixed there is a field or a temperature at which the h-f field (polarized along z) exhibits an absorption maximum whose position and height is dependent on $\omega$. The transverse components are in this case given by

$$\chi_{xx} = \frac{\omega_1^2 - 2i\omega\gamma}{\omega_0^2 - \omega^2 - 2i\alpha\gamma'\omega}\cos^2\theta,$$

$$\chi_{yy} = \frac{1}{\alpha}\frac{\omega_0^2 - 2i\omega\gamma}{\omega_0^2 - \omega^2 - 2i\alpha\gamma'\omega}, \qquad (9),$$

$$\chi_{xy} = -\chi_{yx} = \frac{2igM\omega\cos\theta}{\omega_0^2 - \omega^2 - 2i\alpha\gamma'\omega}.$$

26524
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B102/B231



where

$$\omega_0^2 = (g^2M^2 + \gamma^2)(4\alpha^2\cos^2\theta - 2(\lambda+\eta)\alpha\sin^2\theta), \tag{10}$$

$$\omega_1^2 = 4\alpha(g^2M^2 + \gamma^2), \quad \gamma' = \gamma\left[1 + \cos^2\theta + \frac{1}{2\alpha}(\lambda+\eta)\sin^2\theta\right].$$

3) $H > H_3$, $(\vec{H} \parallel \vec{n})$. Here, the tensor of h-f susceptibility coincides with that of the susceptibility of the uniaxial antiferromagnetic body:

$$\chi_{xx}(\omega) = \chi_{yy}(\omega) = \chi_\perp(0)\frac{\omega_\Phi^2 - i\omega\gamma_\Phi}{\omega_\Phi^2 - \omega^2 - 2i\omega\gamma_\Phi}, \tag{11}$$

$$\chi_{xy}(\omega) = -\chi_{yx}(\omega) = \frac{2igM\omega}{\omega_\Phi^2 - \omega^2 - 2i\omega\gamma_\Phi},$$

$$\chi_{xz} = \chi_{yz} = \chi_{zz} = 0,$$

$$\chi_\perp(0) = 2M/(H + (\lambda-\eta)M), \tag{12}$$

$$\omega_\Phi^2 = g^2[H + (\lambda-\eta)M]^2(1 + \gamma^2/g^2M^2),$$

$$\gamma_\Phi = \gamma(H/M + \lambda - \eta).$$

Card 6/7

With $H = H_3 = (2\alpha - \lambda + \eta)M$ all components of $\chi_{ik}(\omega)$ are continuous. The authors thank A. S. Borovik-Romanov for remarks. There are 7 references: 3 Soviet-bloc and 4 non-Soviet-bloc.

ASSOCIATION: Fiziko-tekhnicheskiy institut Akademii nauk Ukrainskoy SSR (Institute of Physics and Technology of the Academy of Sciences Ukrainskaya SSR)

SUBMITTED: February 17, 1961

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S/056/62/043/003/037/063
B108/B102

24.4400

AUTHORS: Gurzhi, R. N., Tsukernik, V. M.

TITLE: High-frequency magnetic susceptibility of ferromagnetic dielectrics in a longitudinal magnetic field

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 43, no. 3(9), 1962, 977 - 983

TEXT: Using a method similar to Bogolyubov's (ZhETF, 17, 614, 1947) the authors got the following quantum kinetic equation (linear approximation with regard to the variable field $h_t = h_0 e^{-i\omega t}$) for the distribution function $F_k = \langle a_k^+ a_k \rangle$ of spin waves:

$$-i\omega f_k = L_k h_0 + \hat{W} f_k; \tag{11}$$

$$L_k = (\pi\mu\omega/2)\,|B_k|^2\,(2\tilde{n}_k + 1)\,\tilde{\varepsilon}_k^{-2}\,[\delta_-(-2\tilde{\varepsilon}_k - \hbar\omega) - \delta_-(2\tilde{\varepsilon}_k - \hbar\omega)] +$$

$$+ 4\pi\mu\omega \sum_{12} \frac{|\Phi_{k1;2}|^2}{\varepsilon_{k1;2}^2}\,[(1 + n_k + n_1)\,n_2 - n_1 n_k]\,[\delta_-(\varepsilon_{2;1k} - \hbar\omega) - \delta_-(\varepsilon_{k1;2} - \hbar\omega)] +$$

Card 1/4

High-frequency magnetic...

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B108/B102

$$+ 2\pi\mu\omega \sum_{12} \frac{|\Phi_{12;k}|^2}{\varepsilon_{12;k}^2} [(1 + n_1 + n_2)n_k - n_1 n_2] [\delta_-(\varepsilon_{12;k} - \hbar\omega) - \delta_-(\varepsilon_{k;12} - \hbar\omega)],$$

$$\hat{W} f_k = \frac{4\pi}{\hbar} \sum_{12} |\Phi_{k1;2}|^2 [(1 + n_k + n_1) f_2 + (n_2 - n_k) f_1 + (n_2 - n_1) f_k] \times$$

$$\times [\delta_-(\varepsilon_{k1;2} - \hbar\omega) + \delta_-(\varepsilon_{2;k1} - \hbar\omega)] + \frac{2\pi}{\hbar} \sum_{12} |\Phi_{12;k}|^2 [(n_2 - n_k) f_1 +$$

$$+ (n_1 - n_k) f_2 - (1 + n_1 + n_2) f_k] [\delta_-(\varepsilon_{k;12} - \hbar\omega) + \delta_-(\varepsilon_{12;k} - \hbar\omega)] +$$

$$+ \frac{16\pi}{\hbar} \sum_{123} |\Phi_{k1;23}|^2 \{[n_1 (n_2 + 1)(n_3 + 1) - (n_1 + 1) n_2 n_3] f_k + [n_k (n_2 + 1) \times$$

$$\times (n_3 + 1) - (n_k + 1) n_2 n_3] f_1 + [n_k n_1 (n_3 + 1) - (n_k + 1)(n_1 + 1) n_3] f_2 +$$

$$+ [n_k n_1 (n_2 + 1) - (n_k + 1)(n_1 + 1) n_2] f_3\} [\delta_-(\varepsilon_{k1;23} - \hbar\omega) +$$

$$+ \delta_-(\varepsilon_{23;k1} - \hbar\omega)].$$

Card 2/4

with $F_\alpha\big|_{t=0} = n_\alpha = (e^{\varepsilon_\alpha/T} - 1)^{-1}$ and $\langle a^+_\alpha a^+_\beta a_\gamma\rangle\big|_{t=0} = 0$.
$\varepsilon_k = \theta_{Curie}(ak)^2 + \mu H + |B_k|$. At high frequencies it is sufficient to consider the term $-i\omega f_k = L_k h_o$. From this equation the high-frequency magnetic susceptibility of a ferrodielectric with one magnetic sublattice can be calculated keeping in mind that magnetization too can be expressed in terms of the spin wave distribution function:

$$V^{-1}\langle \mathfrak{M}_z\rangle = M_0 - \frac{\mu}{V}\sum_k \langle a_k^+ a_k\rangle, \qquad \langle a_k^+ a_k\rangle = \mathrm{Sp}\,\rho a_k^+ a_k, \qquad (6)$$

Thus, $\chi = -\frac{i\mu}{\omega V}\sum_k L_k$. V is the volume of the body. The real part of magnetic susceptibility which is related to dispersion is

$$\mathrm{Re}\,\chi = \frac{\mu}{\omega V}\sum_k \mathrm{Im}\, L_k.$$

The predominant term in Im $L_k$ is the one proportional to $|B_k|^2$. Con-

sidering this and using the symbols $x = \sqrt{\Theta_{Curie}/T}\,ak$, $\alpha = \hbar\omega/T$, $\eta = \mu H/T$, $\gamma = 4\pi\mu M_0/T$ and $w = \mu^2/a^3$ the result is

$$\mathrm{Re}\,\chi = \frac{w}{4T}\left(\frac{\mu M_0}{T}\right)^2\left(\frac{T}{\Theta_c}\right)^{3/2}\int_0^{\pi}\sin^5\Theta d\Theta\int_{-\infty}^{\infty}\frac{\mathrm{cth}(y(x)/2)}{y(x)}\frac{x^2dx}{y^2(x)-\alpha^2/4},$$

$$y(x) = \sqrt{(x^2+\eta)^2+\gamma(x^2+\eta)\sin^2\Theta}.$$

ASSOCIATION: Fiziko-tekhnicheskiy institut Akademii nauk Ukrainskoy SSR (Physicotechnical Institute of the Academy of Sciences of the Ukrainskaya SSR)

SUBMITTED: March 31, 1962



APPROVED FOR RELEASE: 04/03/2001 CIA-RDP86-00513R001757210007-1"

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ACC NR: AP6018817 SOURCE CODE: UR/0056/66/050/005/1377/1380

AUTHOR: Pikin, S. A.; Tsukernik, V. M.

ORG: none

TITLE: Thermodynamics of linear spin chains in a transverse magnetic field

SOURCE: Zh eksper i teor fiz, v. 50, no. 5, 1966, 1377-1380

TOPIC TAGS: spin system, transverse magnetic field, magnetic susceptibility, THERMODYNAMIC PROPERTY, HOMOGENEOUS MAGNETIC FIELD

ABSTRACT: A one-dimensional system of spins ($s = 1/2$) with a strongly anisotropic interaction of the immediate neighbors has been examined. The system is assumed to be in a homogeneous magnetic field directed along a given axis. Exact equations have been obtained for the thermodynamic characteristics of the system. It has been shown that at $T = 0$ and an absolute value of the magnetic-field strength $H_0$, the magnetic susceptibility has a logarithmic or root nature, dependent, like $H_0$, on the relation between the interaction constants. The authors thank V. G. Vaks and A. I. Larkin for valuable discussions. Orig. art. has: 11 formulas. [Based on authors' abstract] [NT]

SUB CODE: 20/ SUBM DATE: 03Dec65/ ORIG REF: 003/ OTH REF: 002

Card 1/1

L 41744-66 EWT(1) IJP(c) GG

ACC NR: AP6020219 SOURCE CODE: UR/0056/66/050/006/1631/1635

61
B

AUTHOR: Tsukernik, V. M.

ORG: none

TITLE: Features of gyromagnetic effect in ferrodielectrics at low temperatures

SOURCE: Zh eksper i teor fiz, v. 50, no. 6, 1966, 1631-1635

TOPIC TAGS: ferromagnetic dielectric, spin wave theory, dipole interaction, magnetic moment, ground state, temperature dependence

ABSTRACT: The author derives in the spin-wave approximation a formula for the temperature part of the mechanical moment of a spin system and shows that in the region of temperatures where the dipole interaction plays an important role, its ratio to the corresponding addition to the magnetic moment differs from the single-electron g factor and depends on the temperature. The approximation employed consists of expanding, with accuracy to quadratic terms, the energy density in powers of a quantity which is small near the ground state in comparison with the magnetization, followed by quantization and averaging with an equilibrium Gibbs distribution. The deduced difference in the temperature dependence of the magnetic and mechanical moments of the spin system is observable in principle with the aid of a gyromagnetic experiment in which the moments are changed as a result of changes in the temperature in the absence of an external field. The author thanks M. I. Kaganov for useful discussions. Orig. art. has: 20 formulas.

SUB CODE: 20/ SUBM DATE: 18Jan65/ ORIG REF: 004

Card 1/1 Jo

SOURCE: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 48, no. 5, 1965, 1386-1392

TOPIC TAGS: electromagnetic field, field state, field intensity value, wave function, occupation number, quantum electrodynamics

ABSTRACT: Since a free electromagnetic field can be described in quantum theory either by giving the photon occupation numbers or by giving the field strength, the authors consider the problem of finding states of the electromagnetic field in which the electrical or the magnetic field strength has a well defined value. The states of interest are those in which the field strength is given in all of space at one particular time, so that a complete set of the values of the electrical (or magnetic) field strength can be chosen in all

skoy SSR (Institute of Radiophysics and Electronics, Academy of ... Fiziko-tekhnicheskiy institut Akademii nauk Ukrain-

NR REF SOV: 003 OTHER: 002

ZAKHAROV, A.[illegible]; [illegible]ECHER, N.A.; LEKONTSEV, A.N.; RUDNITSKIY, P.M.; [illegible]ALENKO, L.N.; TSCHERNIK, Z.G.; ARYASOV, N.I., inzh., retsenzent; DOVGOPOL, V.I., red.; DUBROV, L.P., red.; GETLING, Yu., red.

[Vanadium of the Kachkanar deposit] Kachkanarskii vanadii. Sverdlovsk, Sredne-Ural'skoe knizhnoe izd-vo, 1964. 302 p. (MIRA 18:11)

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[Metallurgy of ferrrous metals; manual for the training of skilled workers in industry] Metallurgiia chernykh metallov; uchebnoe posobie dlia podgotovki kvalifitsirovannykh rabochikh na proizvodstve. Sverdlovsk, Gos. nauchno-tekhn. izd-vo lit-ry po chernoi i tsvetnoi metallurgii, 1961. 437 p. (MIRA 14:11)
(Iron—Metallurgy) (Steel—Metallurgy) (Metalwork)

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(Electronic instruments)
(Tensiometers)

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Modified spreading rate of the pulse wave in some arrhythmias under experimental conditions. Biul.eksp.biol.i med. 58 no.7:30-32 Jl '64. (MIRA 18:2)

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I.P.Pavlova.
(TAPEWORM INFECTION, compl.
diphyllobothriasis causing anemia (Rus))
(ANEMIA, etiol. & pathogen.
diphyllobothriasis (Rus))

TSUKERSHTEYN, O. YE.

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Some peculiarities in the composition of the blood in diphyllobothriasis in the Far North. Sov.med. 21 Supplement:7 '57. (MIRA 11:2)
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(BLOOD--EXAMINATION)

LINDENBRATEN, L.D. (Leningrad); TSUKERSHTEYN, O.Ye. (Leningrad).

Diagnosis of internal biliary fistulas; symptom of gas in bile ducts. Klin. med. 31 no.8:38-42 Ag '53. (MLRA 6:11)

(Biliary tract) (Fistula)

TSUKERSHTEYN, O.Ye., kand.med.nauk

Case of diabetes mellitus developing under the influence of ACTH and cortisone. Probl.endok.i gorm. no.1:115-116 '62. (MIRA 15:8)

(ACTH) (CORTISONE) (DIABETES)

PANFILOVA, T.A.; TSUKERSHTEYN, O.Ye.; VOL'FE, M.M.

Correlations between functional and morphological changes in experimental cholesterol atherosclerosis in dogs. Pat. fiziol. i eksp. terap. 9 no.5:53-57 S-O '65. (MIRA 19:1)

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Leucocytosis and absolute monocytosis following Valdman's cup endothelial test. Lab. delo 7 no.3:22-25 Mr '61. (MIRA 14:3)

(LEUCOCYTOSIS) (RHEUMATIC FEVER)

TSUKERSHTEYN, V.G., and RUDERMAN, A.I.

"Experimental Studies on the Distribution of X-ray Radiation Doses when Sectorial Irradiation by Means of Swinging X-ray Tubes is being applied", p. 165. Research Into the Field of X-Ray Technique, Vol. 9, Medgiz, Moscow 1955

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Indications for X-ray treatment of esophageal cancer by sector irradiation with a pivoting tube. Trudy TSentr. nauch.-issl. inst. rentg. i rad. 10:226-230 '59. (MIRA 12:9)
(ESOPHAGUS--CANCER) (X RAYS--THERAPEUTIC USE)

TSUKERSHTEYN, V.G.

X-ray treatment of benign vascular tumors. Trudy TSentr. nauch.-issl. inst. rentg. i rad. 10:273-278 '59. (MIRA 10:9)
(X RAYS--THERAPEUTIC USE) (TUMORS)

RUDERMAN, A.I.; TSUKERSHTEYN, V.G.

Experimental study of the distribution of X-ray emission in the case of sectional exposure by oscillating tubes. Trudy TSentr. nauchn. issl.inst.rentg. i rad. 9:165-173 '55. (MLRA 9:12)
(X RAYS)

TSUKERSHTEIN, YE. I.

Diabetes 2. izd-perer. i dop. Leningrad, Gos. ordena Lenina in-t usovershenstvovaniia vrachei im. S.M. Kirova, 1947. 336 P.

DAFM

L. Diabetes

TSUKERSHTEYN, Ye.I. (Prof)

PA 65/49T68

USSR/Medicine - Blood, Cholesterol Mar 49
Blood, Ketone Bodies

"Presence of Ketone Bodies and Cholesterol in the Blood of Hypertonia Cases," Prof Ye. I. Tsukershteyn, Chief, Third Chair of Internal Diseases, M. N. Yegorova, Third Chair of Internal Diseases, State Ord of Lenin Inst for Advancement of Doctors imeni S. M. Kirov, 6 pp

"Klin Med" No 3

Gives results of studying hypertonic cases in three tables. From data obtained, it may be

[redacted] 65/49T68

USSR/Medicine - Blood, Cholesterol Mar 49
(Contd)

assumed that hyperketonemia has a serious effect on the general condition of the patient. Changes in general or alimentary functions affect the content of ketone bodies. In most cases under proper treatment, the cholesterol content in the blood tends to approach normal as general condition and liver functions improve. Dir, State Ord of Lenin Inst for Advancement of Doctors: G. A. Znamenskiy.

[redacted] 65/49T68

TSUKERSHTEYN, Ye.I.; YEGOROVA, M.N.

Barrier liver function in hypertension. Klin. med., Moskva 30 no. 11:90 Nov 1952. (CLML 23:5)

1. Professor for Tsukershteyn. 2. Of the Third Department of Internal Diseases (Head -- Prof. Ye. I. Tsukershteyn), State Order of Lenin Institute for the Advanced Training of Physicians imeni S. M. Kirov.

TSUKERSHTEYN, Ye.I., professor (Leningrad)

Peculiarities of the course of rheumatism in adolescents. Klin. med. 31 no.11:48-52 N '53. (MLRA 6:12)
(Rheumatism)

TSUKERSHTEYN, Ye.I., prof.; TNIMOVA, K.Z., dotsent

Peculiarities in the clinical aspects and treatment of tuberculosis of the lymph nodes of the abdominal cavity. Zdrav. Kazakh. 21 no.1: 43-48 '61. (MIRA 14:3)

1. Iz kafedry gospital'noy terapii (zav. prof. Ye.I.TSukershteyn) Karagandinskogo meditsinskogo instituta.
(LYMPHATICS—TUBERCULOSIS) (ABDOMEN)

TSUKERSHTEYN, Ye.I., prof.; KARLINSKIY, V.M., kand.med.nauk

Prevention of rheumatic fever in adults. Zdrav. Kazakh. 21 no.5: 5-8 '61. (MIRA 15:2)

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(RHEUMATIC FEVER)

1ST AND 2ND ORDERS PROCESSES AND PROPERTIES INDEX 3RD AND 4TH ORDERS

Be

A-3

**Characterization of quinols.** I. TSUKERVANIK (Bull. Univ. Asie Centrale, 1934, No. 19, 49—60).—Toluquinol and $Br_2$ in $CHCl_3$ yield the *dibromide*, an oil, readily decomp. to yield 2-chloro-5-methylquinol; the *tetrabromide*, m.p. 135°, prepared similarly, yields di- and tri-bromo-[illegible] when heated above the m.p., whilst when [illegible] is heated with $H_2O$ the product is 3 : 6-dibromo-5-methylquinol. The *di-*, m.p. 93° (decomp.), and *tetra-chloride*, m.p. 142°, prepared analogously, behave similarly to the above bromides, but are more stable. [illegible] *dibromide*, m.p. 108°, *tetrabromide*, m.p. 150°, *dichloride*, m.p. 112°, and *tetrachloride*, an oil, yield unidentified quinols when heated. R. T.

ASM-SLA METALLURGICAL LITERATURE CLASSIFICATION

BC

a-4

**Composition of (A) *Ferulea drupacea*, M., and of the oil pressed from its seeds, (B) roots of *Ferula pseudoreoselinum*, Lipsky.** I. TSUKERVANIK and V. BERSUTSKI (Bull. Univ. Asie Centrale, 1935, No. 21, 49—54, 55—68).—(A) The air-dry leaves contain hemicellulose (I) 7·7, cellulose (II) 9·2, lignin (III) 5·5, protein 16·8, ash 9·7, $H_2O$-sol. 24, $Et_2O$-sol. substances 13·8%, the roots contain 8·0% of $H_2O$-sol. products, and the seeds contain (I) 6·8, (II) 8·3, (III) 4·1, ash 6·0, $H_2O$-sol. 23·5, EtOH-sol. 2·1, and $Et_2O$-sol. substances 15·4%. The $Et_2O$ extract of the seeds yields a fatty oil, containing saturated (palmitic, stearic) 8, and unsaturated acids (oleic, linoleic, linolenic) 80, resins 4·1, and unsaponifiable 5·0%.

(B) [with C. V. BRUTSKEVA and B. I. AFEIKOVITSCH]. The air-dry root contains (I) 11, (II) 12·4, (III) 4·3, pentosans 6·4, pectins 9·6, starch 7·19, mono- 2·11, and di-saccharides 8·80, protein 7·37, ash 5·82, $H_2O$-sol. 29·6, EtOH-sol. 1·9, and $Et_2O$-sol. substances 15·9% [including resin 12·63 (acids, including podocarpic, 6·1, phenols 62·5, and neutral constituents 20·5%), essential oil 3·3 ($d$-$\alpha$-pinene 90, $d$-$\beta$-phellandrene 5%)]. R. T.

1ST AND 2ND ORDERS

3RD AND 4TH ORDERS

PROCESSES AND PROPERTIES INDEX

Ca

13

**Utilization of cottonseed husks for synthesis of glucose, lactic acid and glycerol.** I. P. Tsukervanik, P. P. Samsonov, L. P. Danilevskii and N. G. Sidorova. *Bull. univ. Asie centrale* No. 21, 60–82(1935).—One kg. of husks is heated for 1 hr. at 26° with 1 l. of 75.5% $H_2SO_4$, undissolved material is removed, 8 l. of $H_2O$ added, and the soln. is boiled (for 3 hrs.) and made neutral with CaO or $CaCO_3$. Glucose is obtained in 27–30% yield from the concd. filtrate and may be fermented to yield lactic acid, or EtOH and glycerol.

B. C. A.

COMMON ELEMENTS

COMMON VARIABLES INDEX

OPEN

MATERIALS INDEX

ASM-SLA METALLURGICAL LITERATURE CLASSIFICATION

AUTHOR INDEX

1ST AND 2ND LETTER

MATERIALS INDEX

3RD AND 4TH ORDERS

1ST AND 2ND ORDERS

PROCESSES AND PROPERTIES INDEX

3RD AND 4TH ORDERS

CA

10

**Alkylation of phenols with alcohols in the presence of aluminum chloride. II. Alkylation with secondary and primary aliphatic alcohols.** I. P. Tsukervanik and Z. N. Nazarova. *J. Gen. Chem.* (U. S. S. R.) 7, 623-31(1937); cf. *C. A.* 30, 443[1].—The difficulties of obtaining alkyl-phenols by catalytic condensation of phenols with second-ary alcs. have been overcome by the use of excess $AlCl_3$ and higher temps. By this method about 70% alkyl-phenols, contg. small amts. of dialkylphenol ethers, $(R_2C_6H_3OR$ (I)) and alkylphenol ethers $(RC_6H_4OR$ (II)), are formed. The proportion of II in the reaction mixt. increases with decrease in the $AlCl_3$ concn. and temp. The probable mechanism of the condensation is: ROH + $AlCl_3 \rightarrow HCl + AlCl_2(OR)$; PhOH + $AlCl_3 \rightarrow HCl$ + $PhOAlCl_2$; $AlCl_2(OR) + PhOAlCl_2 \xrightarrow[HCl]{} PhOR + AlCl_3 + AlCl_2OH$. PhOR is then converted to II either by alkylation: PhOR + ROH + $AlCl_3 \rightarrow$ II + $AlCl_2OH$ + HCl, or by rearrangement: 2 PhOR $\xrightarrow[AlCl_3]{}$ II + PhOH (cf. Smith, *C. A.* 27, 5067). The alkylated ethers are then converted to alkylphenols by the action of the excess of $AlCl_3$ or higher temps. either by sapon.: II + HCl $\xrightarrow[AlCl_3]{}$ $RC_6H_4OH$ + RCl (Hartmann and Gattermann, *Ber.* 25, 3531(1892)), or by rearrangement: II + PhOH $\xrightarrow[AlCl_3]{}$ $2RC_6H_4OH$; 2 II $\xrightarrow[AlCl_3]{}$ $RC_6H_4OH$ + I, (cf. Smith, *loc. cit.*). Condensation of PhOH with MePrCHOH resulted chiefly in a mixt. of *o*- and *p*-$MePrCHC_6H_4OH$ and a little of $Et_2CHC_6H_4OH$ as a result of the isomerization of the alc. radical, which could be effected either by the cleavage of $H_2O$ from the alc. by the action of $AlCl_3$ or by the isomerization of alkylated phenol ether. The condensation of PhOH with primary alcs. was effected by the same method with 2 mols. of $AlCl_3$ to 1 mol. of PhOH and 1 mol. of alc. Condensation of $Me_2CHOH$ with PhOH in petr. ether at 110-20° for 6 hrs. gave 52% *p*-$HOC_6H_4$-$CHMe_2$ (III), m. 61°, (Bz ester m. 71-2°), and about 23% of nonphenolic fraction, b. 225-30°, contg. chiefly *p*-$Me_2CHOC_6H_4CHMe_2$ (IV). Anisole and $Me_2CHOH$ in petr. ether at 120° for 4 hrs. gave 38% of a mixt. of III and *o*-isomer, b. 215-17°, and 50% of *o*- and *p*-$MeOC_6H_4C$-$HMe_2$ contaminated by a little IV. The condensation at 130-40° for 5-6 hrs. resulted in 64% of *o*- and *p*-$HOC_6H_4$-$CHMe_2$ and 30% $MeOC_6H_4CHMe_2$. *m*-Cresol and $Me_2$-CHOH heated at 125° for 6 hrs. gave 66% 3,4-$HOC_6H_3$-$MeCHMe_2$, m. 112°, and 20% 3,4-$Me_2CHOC_6H_3Me$-$CHMe_2$, b. 233-5°. PhOH and EtMeCHOH in ligroin

See other side

ASM-SLA METALLURGICAL LITERATURE CLASSIFICATION

heated at 120-40° for 6 hrs. gave 52% of $EtMeCHC_6H_4OH$ (o-isomer, b. 229-33°, $d_{4}^{20}$ 0.9907, $n_D^{20}$ 1.5182, M. R. 45.80; p-isomer, b. 235-7°, $d_{4}^{20}$ 0.9883, $n_D^{20}$ 1.518), and 13% $EtMeCHOC_6H_4CHMeEt$. In the process of distn. the ether is given into the *sec*-butylphenol. Anisole and EtMeCHOH digested on a water bath for 2 hrs. gave 85% $MeOC_6H_4CHMeEt$, $b_{11}$ 100-70°, $d_{4}^{20}$ 0.9413, $n_D^{20}$ 1.503, M. R. 51.5, 16% $MeOC_6H_3(CHMeEt)_2$, $b_{11}$ 140-2°, $d_{4}^{20}$ 0.9240, $n_D^{20}$ 1.498, M. R. 69.72, and 13% $HOC_6H_4CHMeEt$. PhOH and MePrCHOH allowed to stand at room temp. for 24 hrs. and then heated at 40-50° for 4 hrs. gave 57.5% of phenolic and 13% of nonphenolic fraction. From the phenolic fraction crystd. out $Et_2CHC_6H_4OH$, m. 80° (Bz deriv., m. 40-1°); the residue on fractionation gave p-$MePrCHC_6H_4OH$, $b_{20}$ 130-6° (Bz deriv., b. 255°), and o-isomer, $b_{20}$ 140-50°, $d_{4}^{20}$ 0.9081, $n_D^{20}$ 1.519 (Bz deriv., b. 340-4°). The nonphenolic fraction gave $MePrCHC_6H_4OCHPrMe$, $b_{20}$ 230-40°, and $(MePrCH)_2C_6H_3OCHPrMe$, $b_{20}$ 245-50°, $d_{4}^{20}$ 0.900, $n_D^{20}$ 1.4919. Anisole and MePrCHOH treated as above afforded $MeOC_6H_4CHPrMe$, b. 221-30°, $d_{4}^{20}$ 0.9284, $n_D^{20}$ 1.490, and $MeOC_6H_3(CHPrMe)_2$, b. 245-60°. The condensation of PhOH with MeOH could not be effected. PhOH and abs. EtOH heated at 120-40° for 6 hrs. gave 62% phenolic and 11% nonphenolic products. The phenolic fraction consisted of 60% $Et_2C_6H_3OH$, b. 237°, m. 70-6.5°, and 40% o-$EtC_6H_4OH$, m. 137°, and the p-isomer, b. 216-20°. The nonphenolic fraction on redistn. was completely converted into $Et_2C_6H_3OH$. PhOH and PrOH gave 73.6% o-$PrC_6H_4OH$, b. 223°, $d_{4}^{20}$ 1.0008, and the p-isomer, b. 225-8°, and 17% $PrC_6H_4OPr$, b. 240-5°; this on standing was converted into $PrC_6H_4OH$. PhOH and BuOH gave 72% phenolic and 14% nonphenolic products. o-$BuC_6H_4OH$, b. 232-5°, $d_{4}^{20}$ 0.9713; p-isomer, b. 240-50°, $d_{4}^{20}$ 0.9704 (Bz deriv., m. 25-6°). PhOH and iso-BuOH gave $C_4H_8$ and 82% $Me_3CC_6H_4OH$, m. 98°. PhOH and iso-AmOH gave 3 amylphenols, of which only $Me_2EtCC_6H_4OH$, m. 88-90°, was identified. About 25 references. Chas. Blanc

1ST AND 2ND ORDERS

PROCESSES AND PROPERTIES INDEX

3RD AND 4TH ORDERS

CA

10

**Condensation of alcohols with aromatic hydrocarbons in the presence of anhydrous aluminum chloride. III. Condensation of primary alcohols with benzene and toluene.** I. P. Tsukervanik and G. Vikhrova. *J. Gen. Chem.* (U. S. S. R.) 7, 632-6(1937); cf. C. A. 30, 442[9] and preceding abstr.—The condensation of $C_6H_6$ and PhMe with primary alcs. proceeds more difficultly than with secondary alcs., requiring a large excess of $AlCl_3$ (1.3-2 mols. for 1 mol. of alc.) and longer heating (4-10 hrs.) at higher temps. (110-40°). At optimum conditions 80-94% of mixed alkylated products and no unsatd. hydrocarbons are formed. Greater $AlCl_3$ concn. and higher temps. increase the formation of polyalkyl derivs. The dialkylhydrocarbons are mixts. of *p*- and *m*-isomers with the latter as a chief reaction product (cf. Shoesmith and McGechen, C. A. 25, 2691). PhMe is generally more reactive. With MeOH it gives products of various degrees of alkylation, while $C_6H_6$ fails to react. The 2-stage condensation (prepn. of Al alcoholate and heating it with $C_6H_6$ or PhMe) resulted in smaller yields of alkylated hydrocarbons. The nature of the diethyldiphenyl, $Et(C_6H_4)_2Et$ (I) and diethyltriphenyl, $Et(C_6H_4)_3Et$ (II), formed from $C_6H_6$ and EtOH, is being investigated. Unless otherwise stated, the values given below after the b. p. are for $d_4^{20}$, $n_D^{20}$ and M. R., resp. Heating 16 g. ($^1/_3$ mol.) EtOH, 87 g. ($^2/_3$ mol.) $AlCl_3$ and 120 g. $C_6H_6$ at 120-30° for 10 hrs. resulted in 48.5% PhEt, $b_{745}$ 134-6°, 0.8722, 1.4957, 35.48 and 35% of polyalkylbenzenes. This redistd. gave *m*-$C_6H_4Et_2$, $b_{745}$ 179-81°, 0.8636, 1.4978, 44.71; $C_6H_3Et_3$, $b_{745}$ 215-17°, 0.882, 1.5005, 54.03, mol. wt. 170 (calcd. 160); $C_6H_2Et_4$, b. 240-50°, 0.8899, 1.5032, 63.28, mol. wt. 188 (calcd. 190); I, b. 290-300°, 0.998, 1.5625, 68.28, mol. wt. 208 (calcd. 210), and II m. 280°. From 30 g. (0.5 mol.) PrOH, 87 g. ($^2/_3$ mol.) $AlCl_3$ and 120 g. $C_6H_6$ at 110° for 10 hrs. resulted 51.5% PhPr, b. 150-8°, 0.866, 1.4941, 40.34 and 30.5% *m*-$C_6H_4Pr_2$, b. 215-18°, 0.9137, 1.5155, 53.88. Condensation of 23 g. (0.5 mol.) EtOH, 90 g. (0.75 mol.) $AlCl_3$ and 80 g. PhMe at 140° for 8 hrs. gave 74% *m*-$MeC_6H_4Et$, b. 157-9°, 0.8693, 1.4957, 40.28 and the *p*-isomer, b. 160-3°, 0.8697, 1.4962, 40.23 and 20% $MeC_6H_3Et_2$, b. 198° (the position of the Et groups was not detd.). A mixt. of 30 g. (0.5 mol.) PrOH, 90 g. (0.7 mol.) $AlCl_3$ and 80 g. PhMe heated at 125° for 4 hrs. afforded 0.5% $MeC_6H_3Pr_2$, b. 243-7° and 83% *m*-$MeC_6H_4Pr$, b. 176-9°, 0.8651, 1.4945, 44.84, and the *p*-isomer, b. 182-5°, 0.8682,

IV. Condensation of aliphatic alcohols with naphthalene. I. P. Tsukervanik [illegible] *Ibid.* [illegible] 1.—[illegible] ary and tertiary alcs., forming [illegible] parts of mono- and dialkylnaphth[illegible] $AlCl_3$ of [illegible] (excess $AlCl_3$ and prolonged heating result [illegible] alkylnaphthalenes), 1 mol. to 1 of secondary alc. and 1.5-2 mols. to 1 of primary alc. The detn. of the position of side alkyl groups in the mol. is based on the oxidation of [illegible]

see other side

METALLURGICAL LITERATURE CLASSIFICATION

(CONTINUED)

CA Condensation of alcohols with aromatic hydrocarbons in the presince of anhydrous aluminum chloride. III. Condensation of primary alcohols with benzene and toluene. I.P.Tsukervanik and G. Vikhrova. J. Gen. Chem. (U.S.S.R.) 10

[illegible]

isomer (identified as m-$C_6H_4(CO_2Me)_2$, m. 62°) and sym-$C_6H_3(C_6H_{11})_3$, m. 68°, identified as tri-Me trimesate, m. 144°. PhMe is less reactive, requiring more $AlCl_3$ and a large excess of PhMe. $C_6H_{11}OH$ (70 g.), 80 g. $AlCl_3$ and 200 cc. PhMe gave 72% of a fraction, $b_{752}$ 254-60°, $d_4^{20}$ 0.9343, $n_D^{20}$ 1.5242, M. R. 57.05, consisting of p- and m-$MeC_6H_4C_6H_{11}$, identified as p- and m-$C_6H_4(CO_2Me)_2$, resp., and 18% 3,5-$MeC_6H_3(C_6H_{11})_2$, m. 93.5°, identified as tri-Me trimesate. From the decompn. of $C_6H_{11}OH$ with $AlCl_3$ with the formation of 15-20% $C_6H_{10}$ and 20-5% $C_6H_{11}Cl$ it is assumed that by analogy with tertiary alcs., the condensation of secondary cyclic alcs. with aromatic hydrocarbons proceeds by intermediate cleavage of $H_2O$ with the formation of cycloalkenes and cycloalkyl chlorides: $C_6H_{11}OH + AlCl_3 \rightarrow C_6H_{10} + AlCl_2OH + HCl$; $C_6H_{10} + HCl \xrightarrow[AlCl_3]{} C_6H_{11}Cl$; $C_6H_6 + C_6H_{10} \xrightarrow[AlCl_3]{}$ Ph-$C_6H_{11}$; $C_6H_{11}Cl + C_6H_6 \xrightarrow[AlCl_3]{} PhC_6H_{11} + HCl$. C. B.

ASM-SLA METALLURGICAL LITERATURE CLASSIFICATION

1ST AND 2ND GROUPS

PROCESSES AND PROPERTIES INDEX

10

ca

**Condensation of alcohols with aromatic hydrocarbons in the presence of anhydrous aluminum chloride. VI. Alkylation of halogenated aromatic hydrocarbons by alcohols.** I. P. Tsukervanik. *J. Gen. Chem.* (U. S. S. R.) 8, 1512-15(1938); cf. *C. A.* 31, 5780[a].—The preliminary exptl. data on the condensation of excess of PhCl, o-$ClC_6H_4Me$ (I) and 1-$C_{10}H_7Cl$ (II) with alcs. in the presence of $AlCl_3$ at elevated temps. show that the alkylation of aryl halides proceeds analogously to that of unsubstituted aromatic hydrocarbons with the formation of corresponding monoalkyl- (40-65% yield) and polyalkylaryl chlorides. The alkyl derivs. represent mixts. of p- and some m-isomers, the constitution of which was detd. by oxidation to the corresponding chlorobenzoic acids. The condensation with primary alcs. (EtOH) proceeds most difficultly (requiring a large excess of $AlCl_3$ (1.5 g./mol.); with secondary alcs. less difficultly (1 g./mol. $AlCl_3$); and with tertiary alcs. very easily (0.5 g./mol. $AlCl_3$). Greater $AlCl_3$ concns. and higher temps. increase the formation of polyalkyl derivs. The reactions are effected by gradual addns. of $AlCl_3$ to a mixt. of an aryl chloride and an alc. and refluxing on a boiling water bath for 2-3 hrs. Unless otherwise stated, the values given below are for $b_{760}$ and $d_{20}^{20}$, resp. The reaction of 37 g. *tert*-BuOH and 100 g. PhCl with 30 g. $AlCl_3$ gave 11 g. polyalkyl chlorides (III) and 65% of isomeric *tert*-$BuC_6H_4Cl$; p-isomer, 210-12°, 1.0029, $n_D^{20}$ 1.5125. PhCl (100 g.) and 44 g. *tert*-AmOH with 25 g. $AlCl_3$ gave 8 g. III and 50% p- and m-*tert*-$AmC_6H_4Cl$; p-isomer, 224-9°, 1.0068, $n_D^{20}$ 1.5139. PhCl (100 g.) and 60 g. iso-PrOH with 120 g. $AlCl_3$ gave 62% chlorocumenes; p-isomer, 195-7°, 1.0022, $n_D^{20}$ 1.514. PhCl (100 g.) and 44 g. *sec*-BuOH with 59 g. $AlCl_3$ gave 8 g. III and 50% isomeric *sec*-$BuC_6H_4Cl$; p-isomer, 212-14°, 1.001, $n_D^{20}$ 1.4995. PhCl (100 g.) and 30 ml. EtOH with 120 g. $AlCl_3$ gave 10 g. III and 40% p-$EtC_6H_4Cl$, 179-80°, 1.0463, $n_D^{20}$ 1.5235. PhCl (150 g.) and 74 g. iso-BuOH with 200 g. $AlCl_3$ gave 25 g. III and 30% of monoalkyl derivs., from which was isolated p-*tert*-$BuC_6H_4Cl$. PhCl (100 g.) and 44 g. iso-AmOH with 80 g. $AlCl_3$ gave 15 g. III and 35% monoalkyl derivs.; p-*tert*-$AmC_6H_4Cl$, 224-30°, 1.007, $n_D^{20}$ 1.5130. I (25 g.) and 19 g. *tert*-BuOH with 15 g. $AlCl_3$ gave 45% monoalkyl derivs.; *tert*-$BuMeC_6H_3Cl$, 225-30°, 1.0076, $n_D^{20}$ 1.5145. II (120 g.) and 44 g. *tert*-AmOH with 30 g. $AlCl_3$ gave 15 g. III and 60% monoalkyl derivs.; *tert*-amyl-1-chloronaphthalene, 310-12°, 1.1235, $n_D^{20}$ 1.6009. II (75 g.) and 30 g. iso-PrOH with 60 g. $AlCl_3$ gave 12 g. III and 45% isopropyl-1-chloronaphthalene, b. 305-10°, 1.1421, $n_D^{20}$ 1.6043. Chas. Blanc

ASM-SLA METALLURGICAL LITERATURE CLASSIFICATION

TSUKERVANIK, I. P.

**Benzylstibine and its derivatives.** I. P. Tsukervanik and D. Smirnov. *J. Gen. Chem.* (U. S. S. R.) 7, 1527-31 (1937).—$PhCH_2MgCl$ and $SbCl_3$ in a $CO_2$ atm. give *tribenzylstibine* (I), m. 90°, which is easily oxidized by air, especially in soln., to *tribenzylstibine oxide* (II). I reacts with $Cl_2$ and $Br_2$, or II with HCl and HBr, to give the *dichloride* m. 100-1°, and the *dibromide* m. 107-9°, resp. When I is heated with $SbCl_3$, it forms $(PhCH_2)_2SbCl$, m. 187-8°, which gives with dil. $Na_2CO_3$ soln. $[(PhCH_2)_2SbO]_2O$. With HBr this forms $(PhCH_2)_2SbBr_3$, m. 150-1° (decompn.). H. M. Leicester

ASM-SLA METALLURGICAL LITERATURE CLASSIFICATION

**Condensation of alcohols with aromatic compounds in the presence of aluminum chloride. IX. Condensation of 1,2-methylcyclohexanol, menthol and borneol with benzene and toluene.** I. P. Tsukervanik and N. G. Sidorova. *J. Gen. Chem.* (U. S. S. R.) 8, 1860-1862 (in English, 1862)(1938); cf. *C. A.* 33, 4587[9]. The following compds. were prepd.: *methylcyclohexylbenzene*, $C_{13}H_{18}$ (42.5% yield), $b_{10}$ 142-3°, $d_4^{20}$ 0.9608, $n_D^{20}$ 1.5290; *(methylcyclohexyl)toluene* isomers (50% yield), $b_{10}$ 152-4°, $d_4^{20}$ 0.9250, $n_D^{20}$ 1.5265; menthylbenzene $C_{16}H_{24}$ (I) (54.3% yield), $b_{10}$ 151-4°, $d_4^{20}$ 0.9342, $n_D^{20}$ 1.5207, *p*- and *m*-*menthyltoluene* (61% yield), $b_{10}$ 163-8°, $d_4^{20}$ 0.9211, $n_D^{20}$ 1.5185; bornylbenzene, $C_{16}H_{22}$ (30% yield), $b_{10}$ 165-8°, $d_4^{20}$ 0.9535, $n_D^{20}$ 1.5250; *p*- and *m*-bornyltoluene (64% yield), $b_5$ 131-3°, $d_4^{20}$ 0.9590, $n_D^{20}$ 1.5275. In the prepn. of I 3-menthene, b. 165-9°, $d_4^{20}$ 0.8103, $n_D^{20}$ 1.4470, and *tert*-menthyl chloride, $C_{10}H_{19}Cl$, $b_{10}$ 117-8°, $d_4^{20}$ 0.9105, $n_D^{20}$ 1.4670, were the chief products when insufficient $AlCl_3$ was used. Small amts. of polyalkylated hydrocarbons were always obtained but not identified. John Livak

ASM-SLA METALLURGICAL LITERATURE CLASSIFICATION

1ST AND 2ND ORDERS

PROCESSES AND PROPERTIES INDEX

3RD AND 4TH ORDERS

CA

10

COMMON ELEMENTS

**Reciprocal action of acetylketene and alcohols.** I. I. P. Tsukervanik and I. A. Ermolenko. *Bull. univ. Asie centrale* 22, 215-20(in German, 220)(1938).—The reaction between *acetylketene* and various alcs. and some other compds. has been investigated. The acetylation proceeds even in the cold in the absence of catalysts. The catalysts tested were quinoline, $H_2SO_4$ and $ZnCl_2$. Only in acetylating *glycerol* the presence of $H_2SO_4$ is of advantage. The reaction proceeds smoothly and the yield is almost theoretical in the case of primary and secondary alcs., whereas the acetylation of tertiary alcs. proceeds much more slowly. Glycerol and *glycol* give a mixt. of mono- and diacetates. Unsatd. alcs. react only with the HO group with the formation of normal acetates. The acetylation of *p-anisidine* gives 98% of pure acetate. *Aspirin* is obtained in 98% of the theoretical yield from salicylic acid. Gertrude Berend

ASM-SLA METALLURGICAL LITERATURE CLASSIFICATION

C T

10

**Alkylation of phenol and anisole by the Friedel-Crafts method.** I. P. Tsukervanik and V. D. Tambovtseva. *Bull. univ. Asie centrale* 22, 221-4 (in German, 225) (1938). Alkylation of phenol (I) and anisole (II) has been carried out with BuCl (III), iso-BuCl (IV) and iso-AmCl (V) in the presence of an equimol. amt. of $AlCl_3$. In the case of II, the most favorable conditions were 4 hrs. heating of the mixt. on the water bath, using ligroin as a solvent, whereby a mixt. of *o*- and *p*-alkylanisole is obtained in 70% of the theoretical yield and small amts. of dialkylanisoles. Sapon. of II occurs simultaneously to some extent with the formation of phenol. In the case of I, longer heating to higher temps. is required. The best yield, up to 60% of the theory, is obtained in the absence of a solvent. In addn. to a mixt. of *o*- and *p*-alkylphenols, alkyl ethers of phenol are formed. To 25 g. II, 20 g. V and 100 ml. ligroin, 35 g. $AlCl_3$ is added slowly within 1 hr. and the mixt. heated for 4 hrs. on a boiling water bath. Isoamylanisole (16 g.), $b_{11}$ 120-2°, $d_{20}^{20}$ 0.9401, $n_D^{20}$ 1.4995, and 3 g. diisoamylanisole, $b_{11}$ 137-40°, $d_{20}^{20}$ 0.9511, $n_D^{20}$ 1.5112, are formed. II (22 g.), 20 g. III, 35 g. $AlCl_3$, and 100 ml. ligroin when heated for 4 hrs. on a boiling water bath give 21 g. butylanisole from which is isolated *p*-butylanisole, $b_{11}$ 108-10°, $d_{4}^{20}$ 0.9273, $n_D^{20}$ 1.5020, and 3 g. dibutylanisole, $b_{11}$ 136-7°, $d_{4}^{20}$ 0.9288, $n_D^{20}$ 1.5105. By heating 60 ml. II with 20 g. IV and 27 g. $AlCl_3$ there is formed 13 g. isobutylanisole, $b_{11}$ 126-7°, $d_{20}^{20}$ 0.9572, $n_D^{20}$ 1.4960. I (19 g.), 20 g. III and 27 g. $AlCl_3$ on heating for 4 hrs. to 110° give 9 g. butylphenol, from which is isolated the *p*-isomer, $b_{11}$ 120-30°, $d_{20}^{20}$ 0.9749, $n_D^{20}$ 1.5180, 5 g. I and 4 g. of butylphenol Bu ether, $b_{11}$ 144-7°, $d_{20}^{20}$ 0.9649, $n_D^{20}$ 1.5000. I (19 g.), 22 g. V and 27 g. $AlCl_3$ heated for 5 hrs. on a boiling water bath give 4 g. isoamylphenol, $b_{11}$ 130-3°, $n_D^{20}$ 1.5202, 10 g. I and 6 g. of isoamylphenol isoamyl ether. When $AlCl_3$ is added with cooling, 55% *tert*-amylphenol, m. 92°, are obtained instead of isoamylphenol. Gertrude Berend

**Condensation of aldehydes and ketones with aromatic hydrocarbons in the presence of anhydrous aluminum chloride. I. Condensation of aliphatic ketones with phenols.** I. P. Tsukervanik and Z. N. Nazarova. *J. Gen. Chem.* (U. S. S. R.) 9, 33-5(1939); cf. *C. A.* 31, 5778[a].—The interaction of aliphatic ketones with PhOH in the presence of excess $AlCl_3$ (1.5 mols.) in the cold for 1-3 days yields dialkyl diphenolmethanes, which on heating decomp. to give *p*-*alkyl phenols*. The latter are formed directly in 40% yield by condensation of the reaction mixt. on the water bath for 3-4 hrs. The mechanism of the condensation reaction is analogous to the similar procedure in the presence of fuming HCl studied by Dianin (*J. Russ. Phys.-Chem. Soc.* 23, 488, 523, 601(1891); cf. *loc. cit.*). In this way were prepd. *isopropylphenol* (from $Me_2CO$ and PhOH), b. 200-30° (and considerable resinification products) and *sec-amylphenol* (I) (from $Et_2CO$), m. 79°, b. 245-60° (*Bz deriv.*, m. 48-50°). MeCOPr also formed I, b. 245-50°, $d_{20}^{20}$ 0.97, $n_D^{20}$ 1.5215. It gives a *Bz deriv.*, $b_{10}$ 340-50°, *Ac deriv.*, b. 254-5°, and *Me ether*, b. 232-8°, which with $CrO_3$ is oxidized to anisic acid, m. 179°. Condensation of *m*-cresol with $Me_2CO$ produced an anhydride, m. 131°, described by Zincke and Gaebel (*C. A.* 6, 1751). Chas. Blanc

ASM-SLA METALLURGICAL LITERATURE CLASSIFICATION

PROCESSES AND PROPERTIES INDEX

C9

10

**Alkylation of aromatic hydrocarbons by dihalogen derivatives. I. Condensation of 1,3-chlorobromopropane with benzene.** I. Tsukervanik and K. Yatsimirskii. *J. Gen. Chem.* (U.S.S.R.) 10, 1075-6(1940).—When $Cl(CH_2)_3Br$ and $C_6H_6$ react in the presence of $AlCl_3$ at 6-12°, 40% $Ph(CH_2)_3Br$ (I) is formed. At 80.5°, 60% $Ph(CH_2)_3Ph$ is formed, with some PhPr as a by-product, but no I is obtained. H. M. Leicester

Lab. of Organic Chem., Cen. Asian State Univ.

ASM-SLA METALLURGICAL LITERATURE CLASSIFICATION

1ST AND 2ND ORDERS

PROCESSES AND PROPERTIES INDEX

3RD AND 4TH ORDERS

ca

10

**The alkylation of aromatic compounds by alcohols in the presence of anhydrous ferric chloride.** Z. N. Nazarova and I. P. Tsukervanik. *J. Gen. Chem.* (U. S. S. R.) 10, 1181-5(1940).—Tertiary alcs. react easily at room temp. with $C_6H_6$, MePh, $C_{10}H_8$, PhOH, *m*- and *p*-cresols and MeOPh to give 70-95% yields of monoalkyl derivs., in the presence of 0.5 equiv. $FeCl_3$ per equiv. of alc. If the mixt. is heated, some *p*-dialkyl compds. are also formed. With secondary alcs., a 1:1 mixt. of $FeCl_3$ and alc. is required and the mixt. must be heated to 50-60° to get 38-75% yields of *o*- and *p*-derivs. With primary alcs., ease of reaction depends on structure, branched-chain alcs. reacting faster than normal alcs. H. M. Leicester

ASA-SLA METALLURGICAL LITERATURE CLASSIFICATION

1ST AND 2ND ORDERS

PROCESSES AND PROPERTIES INDEX

3RD AND 4TH ORDERS

CB

10

**The condensation of aromatic compounds with acids. I. Condensation with hydrocarbons, phenol and phenetole.** I. Tsukervanik and I. Terent'eva. *J. Gen. Chem.* (U. S. S. R.) 10, 1103-7(1940).—Iso-BuCO$_2$H (30 g.) in 100 cc. PhMe was treated with small portions of AlCl$_3$ (total 78 g.). After adding all the AlCl$_3$ the reaction mixt. was allowed to stand for 12 hrs. and then was heated in a water bath for 5-6 hrs. *p*-Methylisovalerophenone, obtained in 72% yield, b$_{760}$ 254-5°, b$_{18}$ 137°, $d_4^{20}$ 0.9574, $n_D^{20}$ 1.5085, MR$_D$ 54.39; semicarbazone, m. 215-16°; oxime, 65°. Oxidation of the product with 10 parts of 5% HNO$_3$ in a sealed tube for 10 hrs. yielded *p*-MeC$_6$H$_4$CO$_2$H. Condensation of PrCO$_2$H in PhMe in the presence of AlCl$_3$ under the same conditions yielded *p-methylbutyrophenone* (72.5%), b. 248-50°, $d_4^{20}$ 0.9900, $n_D^{20}$ 1.5232, MR$_D$ 51.20; semicarbazone, m. 200-10°. On the oxidation of the product *p*-MeC$_6$H$_4$CO$_2$H was sepd. Under the same conditions EtOPh condensed with iso-BuCO$_2$H in the presence of AlCl$_3$, yielding *p-ethoxyisovalerophenone* (82%), b$_{18}$ 133-7°, $d_4^{20}$ 1.0406, $n_D^{20}$ 1.5332, MR$_D$ 61.01 (semicarbazone, m. 191-2°; oxime, m. 118-19°); and *p*-hydroxyisovalerophenone (9%) m. 95-6°. Phenetole with PrCO$_2$H yielded *p-ethoxybutyrophenone* (76%), b. 129°, $n_D^{20}$ 1.5390, MR$_D$ 57.03 (semicarbazone, m. 181°; oxime, m. 103-4°), and *p-hydroxybutyrophenone*, m. 91-2° (semicarbazone, m. 167-9°; oxime, m. 83-4°). The condensation of PhOH with iso-BuCO$_2$H in C$_6$H$_6$ under the same conditions yielded *p*- and *o-hydroxyisovalerophenones* (total yield 63%); the *o*-deriv. b. 248-50°, $d_4^{20}$ 1.0197, $n_D^{20}$ 1.5126, MR$_D$ 52.99.

A. A. Podgorny

ASB-SLA METALLURGICAL LITERATURE CLASSIFICATION

PROCESSES AND PROPERTIES INDEX

**Condensation of alcohols with aromatic hydrocarbons in the presence of aluminum chloride. Condensation of cycloheptanol with benzene and toluene.** N. G. Sidotova and L. P. Tsukervanik. *J. Gen. Chem.* (U. S. S. R.) **10**, 2073-6(1940).—A yield of 40-50% of cycloheptylbenzene (I) and cycloheptyltoluene (II) was obtained on condensation of cycloheptanol (III) with benzene (IV) and toluene (V). III was prepd. by the reduction of cycloheptanone by the method of Mosettig and Burger (*C. A.* 24, 1767); 10 g. of III, 12 g. $AlCl_3$ and 100 ml. IV yielded 7 g. I, $b_{10}$ 132-6°, $d_4^{20}$ 0.9410, $n_D^{20}$ 1.5317, $MR_D$ 56.42, calcd. 56.43. Oxidizing I with 15% $HNO_3$ in sealed tubes at 140-50° yielded BzOH, m. 119°. *p*-Cycloheptylnitrobenzene (VI) was obtained on nitrating I with a nitration mixt. VI $b_{10}$ 203-10°. Oxidizing VI with 15% $HNO_3$ in sealed tubes gave *p*-$O_2NC_6H_4CO_2H$, m. 230°. The *p*-amino deriv. (VII) of I was obtained on reduction of VI with Sn and HCl, and was purified by steam distn. The benzoate of VII (from alc.) m. 173°; acetate (from 80% alc.) m. 130-7°. The acetamino and benzamino derivs. of phenylcyclohexylmethane (VIII) and 1-methyl-2-phenylcyclohexane (IX), which were specially prepd., differed from the derivs. of I. *Synthesis of* VIII. Phenylcyclohexylcarbinol (X) was obtained by Grignard's reaction from 10 g. Mg, 68 g. bromocyclohexane, 44 g. BzH in 100 ml. of abs. ether. The yield was 34.5 g. (45.6%), $b_4$ 130-42°. Ph cyclohexyl ketone (XI) was formed by the oxidation of X. To 31.5 g. of the heated X was added dropwise 18.5 g. $Na_2Cr_2O_7$ in 45 ml. of $H_2O$ and 13 ml. $H_2SO_4$. The reaction product was extd. with ether. After the ether was evapd. thin needles of XI, m. 54°, were obtained. The yield was 31 g. (91%). Phenylcyclohexylmethane (XII) was obtained by the reduction of XI by the Clemmensen method. The yield was 52%. XII $b_{10}$ 137°, $d_4^{20}$ 0.9436, $n_D^{20}$ 1.5255, $MR_D$ 56.58, calcd. 56.43. The (nitrophenyl)cyclohexylmethane, $b_{10}$ 18[illegible] 92°. The corresponding amine was obtained on reducing with Sn and HCl. The N-Bz deriv. (from dil. alc.) m. 161-2°. The N-Ac deriv. (from dil. alc.) m. 170-1°. *Synthesis of* IX. 3-Methyl-2-phenylcyclohexene (XIII) was obtained by Grignard's reaction from 4 g. Mg, 26 g. bromobenzene and 18 g. of 2-methylcyclohexanone in 50 ml. of abs. ether. The yield was 12 g. (42%), $b_{10}$ 112-15°. 1-Methyl-2-phenylcyclohexane (XIV) was obtained on heating 12 g. of XIII with 12.5 ml. HI (d. 1.7) and 0.75 g. of red P in a sealed tube, for 6 hrs., at 190-200°. XIV $b_{10}$ 91-2°, $d_4^{20}$ 0.9399, $n_D^{20}$ 1.5300, $MR_D$ 56.75 (calcd. 56.43). The nitro and the corresponding amino compds. were obtained from XIV by the usual method. The N-Bz deriv., m. 109-74°. The N-Ac deriv. was a liquid, $b_{10}$ 195-200°. II was obtained on treating 5 g. of III with 50 ml. of V and 6 g. of $AlCl_3$. The yield was 4 g. of II (a mixt. of *m*- and *p*-isomers), $b_{10}$ 110-12°, $d_4^{20}$ 0.9350, $n_D^{20}$ 1.5245, $MR_D$ 60.81 (calcd. 61.05). II oxidized with dil. $HNO_3$ yielded a mixt. of tere- and isophthalic acids, which were identified by their di-Me esters. The conclusion is drawn that the conversion of the 7-membered ring to a 6-membered ring on condensation of III with IV and V proceeds only to a small extent.

James J. Lichtin

ASM-SLA METALLURGICAL LITERATURE CLASSIFICATION

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PROCESSES AND PROPERTIES INDEX

CA 10

**Alkylation of aromatic compounds with alcohols in the presence of anhydrous $FeCl_3$.** Z. N. Nazarova and I. P. Tsukervanik. *J. Gen. Chem.* (U. S. S. R.) 14, 77-80 (1944)(English summary).—Attempts to effect a condensation between benzene and PhOH on one hand and primary alcs. (EtOH, PrOH and BuOH) on the other hand failed to give more than traces of alkaryl derivs. $PhCH_2OH$ (30 g.), benzene (50 g.) and 32 g. $FeCl_3$ heated to 70° for 4 hrs. gave 58% $Ph_2CH_2$, b. 200-5°, m. 27°. $PhCH_2OH$ (20 g.), PhOH (20 g.) and 15 g. $FeCl_3$ mixed, let stand for 24 hrs. and heated on a steam bath for 2 hrs. gave 58% *benzylphenol*, b. 300-30°, m. 83°. Allyl alc. (15 g.), 40 g. benzene and 25 g. $FeCl_3$ were mixed with cooling, let stand for 24 hrs. and finally heated for 2-3 hrs. on a steam bath to 80° to yield 8% crude *allylbenzene* and 32% *(2-chloropropyl)benzene;* the purified compds. had the following consts., resp.: b. 154-6°, $n_D^{20}$ 1.5110, $d_4^{20}$ 0.8960, and $b_{m}$ 200-5°, $n_D^{20}$ 1.5147, $d_4^{20}$ 1.0349. This reaction conducted at room temp. (3 days' standing) gave the 2 products in reverse ratio: 33% and 8%, resp. Allylbenzene yields a *tribromide*, m. 118°. Similarly, PhMe gave *allyltoluene*, b. 178-80°, $n_D^{20}$ 1.5085, $d_4^{20}$ 0.8918, and *(2-chloropropyl)toluene*, b. 220-30°, $n_D^{20}$ 1.5194, $d_4^{20}$ 0.9854.

G. M. Kosolapoff

ASM-SLA METALLURGICAL LITERATURE CLASSIFICATION

1ST AND 2ND ORDERS

PROCESSES AND PROPERTIES INDEX

3RD AND 4TH ORDERS

Ca

10

**The mechanism of alkylation reactions under the influence of anhydrous $FeCl_3$.** Z. N. Nazarova and I. P. Tsukervanik. *J. Gen. Chem.* (U.S.S.R.) 14, 236–44 (1944)(English summary); cf. *C.A.* 39, 916[3].—EtBr and $FeCl_3$ form HBr and EtCl, PrBr gives iso-PrCl, and iso-AmBr gives $C_5H_{10}$ and mixts. of AmCl and AmBr. When EtBr and $C_6H_6$ are heated with $FeCl_3$, HCl, EtCl, and PhBr are formed. EtI gives an analogous reaction. Under similar conditions PrBr gives iso-PrCl, PhBr, $BrC_6H_4Pr$, and a little PhPr; iso-BuBr gives PhBr, *tert*-BuPh, iso-BuPh and a mixt. which probably contains $BrC_6H_4Bu$, and $Bu_2C_6H_4$. BuCl and AmCl give almost no reaction with $C_6H_6$ and $FeCl_3$. EtOH and $FeCl_3$ give 87% EtCl. With $FeCl_3$, PrOH gives iso-PrCl and a little PrCl. BuOH gives BuCl and some *sec*-BuCl. Iso-BuOH gives *tert*-BuCl and diisobutylene. $FeCl_3$ dissolves in iso-AmOH, and on standing very hygroscopic crystals sep. which m. 48°, evolve HCl at 58°, and solidify at 105° to a green, nonhomogeneous mass. Iso-PrOH gives iso-PrCl; *sec*-BuOH gives $C_4H_8$, *sec*-BuCl, and *tert*-BuCl; *tert*-AmOH gives $C_5H_{10}$, and *tert*-AmCl. Iso-PrOPh is isomerized by $FeCl_3$ to $PrC_6H_4OH$ and much tar is formed. These reactions are interpreted in terms of formation of an ionized complex of the type $(ROH.FeCl_3)^+Cl^-$ which decomps. in various ways to give the products observed. Alkylation with $FeCl_3$ is thus not a simple condensation, as with $AlCl_3$, but involves rupture of C bonds and deep-seated changes in structure. H. M. Leicester

Lab. Organic Chem. Faculty, State Univ., -1943-

ASM-SLA METALLURGICAL LITERATURE CLASSIFICATION

Ca

10

Condensation of alcohols with aromatic compounds in the presence of aluminum chloride. XI. Mechanism of alkylation of aromatic hydrocarbons by alcohols. I. P. Tsukervanik (Middle Asiatic State Univ.). *J. Gen. Chem.* (U.S.S.R.) 15, 635-8(1945)(English summary).—The cleavage of reaction products of alcs. with $AlCl_3$ was studied at temps. above 100°; contrary to Norris and Sturgis (*C.A.* 33, 6233[9]), only low yields of alkyl chlorides were obtained. It was shown that addn. of 5-10% $FeCl_3$ to $AlCl_3$ markedly raises the yield of RCl on cleavage of the $AlCl_2OR$. EtOH (23 g.) was added over 5 hrs. to 67 g. $AlCl_3$; vigorous evolution of HCl was observed and the resulting solid was slowly heated to 155° with collection of the distillate in a well-cooled receiver; there were obtained 37% EtCl and 3 g. $Et_2O$. Similarly, iso-PrOH gave 25% iso-PrCl and PrOH gave 10% PrCl (at 115-20°). EtOH (23 g.) was similarly added to 64 g. $AlCl_3$ and 3.5 g. $FeCl_3$; the resulting mass m. 100°, while heating to 125° produced foaming and evolution of EtCl, with the reaction being complete at 150°; there was obtained 70% EtCl. Use of 60 g. $AlCl_3$ and 7 g. $FeCl_3$ as above gave 98% EtCl. Iso-PrOH (12 g.), 20 g. $AlCl_3$, and 3 g. $FeCl_3$ gave 73% iso-PrCl; 30 g. PrOH, 60 g. $AlCl_3$, and 7 g. $FeCl_3$ gave 54% PrCl, while 37 g. BuOH, 60 g. $AlCl_3$, and 7 g. $FeCl_3$ gave 10% BuCl. Iso-AmOH failed to yield iso-AmCl. $AlCl_3$ (30 g.) was slowly added to 20 cc. iso-BuOH in 50 cc. $CS_2$ with cooling, after which the mass was warmed on a water bath until the HCl evolution ceased and 2 layers formed; the top layer on cooling gave a crop of colorless crystals of iso-$BuOAlCl_2$ (22.5%); use of petr. ether instead of $CS_2$ gave an analogous result with a 32% yield of the product; treatment of this with water gave iso-BuOH, while addn. of 20 g. of the complex to 30 cc. benzene and 20 cc. AcCl gave 60% PhAc (the reaction was run with effective cooling); similar reaction with BzCl gave 50% $Ph_2CO$.
G. M. Kosolapoff

MDR., LAB. ORGANIC CHEMISTRY, SVERDLOVSK STATE UNIV., -1940-

ASM-SLA METALLURGICAL LITERATURE CLASSIFICATION

1ST AND 2ND ORDERS

3RD AND 4TH ORDERS

PROCESSES AND PROPERTIES INDEX

Ca

10

**Alkylation of aromatic compounds in the presence of phosphoric acid. I. Condensation of alcohols with aromatic hydrocarbons and halides.** I. P. Tsukervanik (Middle Asiatic State Univ.). *J. Gen. Chem.* (U.S.S.R.) 15, 699-703 (1945) (English summary).—It was shown that $H_3PO_4$ may be used for alkylation of aromatic compds. by alcs., with yields up to 80-90% being obtained in the best cases. Considerable polysubstitution occurs, *p*-isomers predominating in disubstituted products, with occasional traces of the *o*-isomers. The iso alcs. usually isomerize into tertiary radicals. The mixt. of aromatic compd. and $H_3PO_4$ was treated, with stirring, with the alc. which was added slowly, and the mixt. was heated and stirred for 6-10 hrs.; on cooling, the org. layers were fractionated. Thus, 100 cc. benzene, 37 g. iso-BuOH, and 110 cc. $H_3PO_4$ (d. 1.85) gave, after 10 hrs. at 90°, 3 g. PhBu, b. 165-70°, with almost all benzene being recoverable; the use of toluene and iso-AmOH as above gave 30% mixed amyltoluenes, principally *p*-$AmC_6H_4Me$, $b_{750}$ 204-6°. Toluene and iso-BuOH gave 50% mixed butyltoluenes, principally *p*-*tert*-$BuC_6H_4Me$, $b_{750}$ 193-6°. Toluene and iso-PrOH gave 80% *p*-cymene; toluene and EtOH gave a very low yield of ethyltoluene, b. 157-60°. Toluene and allyl alc. gave 10% allyltoluene, $b_{750}$ 183-6°, and 40% diallyltoluene, $b_{750}$ 302-7°. Toluene (75 cc.), 46 g. BuCl, and 110 cc. $H_3PO_4$, after 12 hrs. at 90°, gave 15% butyltoluene isomers, b. 185-95°, while *tert*-BuBr gave 37% *p*-$Me_3CC_6H_4Me$. PhBr (80 g.), 37 g. iso-BuOH, and 100 cc. $H_3PO_4$ gave, after 8 hrs. at 126-30°, 30% $BuC_6H_4Br$; a higher temp. gave a higher yield but also caused much tar formation; the use of PhCl gave 30% *p*-$Me_3CC_6H_4Cl$, b. 210-12°, while PhCl and *n*-PrOH gave 90% mixed propylchlorobenzenes, b. 185-95°, with a considerable amt. of *p*-$PrC_6H_4Cl$, b. 190-2°. Benzene and borneol at 70° (10 hrs.) gave 25% bornylbenzene, $b_{10}$ 145-8°.

G. M. Kosolapoff

MDR., LAB. ORGANIC CHEM., MIDDLE ASIATIC STATE UNIV.,

ASM-SLA METALLURGICAL LITERATURE CLASSIFICATION

PROCESSES AND PROPERTIES INDEX

P.L. 1C

**Alkylation of aromatic compounds in the presence of phosphoric acid. II. Alkylation of phenol and anisole by alcohols.** V. Tambovtseva and I. Tsukervanik. *J. Gen. Chem.* (U.S.S.R.) 15, 820-4(1945); cf. C.A. 40, 5707[4].—PhOH and PhOMe were condensed in the presence of 1.5 mols. 95% $H_3PO_4$ with *tert*-AmOH at 70-80°, with iso-PrOH and iso-BuOH at 80-100°, and with PrOH and BuOH at 100-30° to form 80-95% of the corresponding *p*-alkyl derivs. and sometimes a small amt. of the *o*-derivs. Below these temps., reaction did not occur. During the condensation, primary groups isomerized to secondary, and secondary to tertiary. Isolation of $PO(OBu)O_2Ba$ from one reaction mixt. indicates that the reaction goes through the formation of acid esters of $H_3PO_4$ which are in turn the alkylating agents. With PhOMe both Pr and iso-Pr alcs. yielded *p*-isopropylanisole, $b_{760}$ 212-14°, $d_{20}^{20}$ 0.9418, $n_D^{20}$ 1.5070, and *o*-isopropylanisole, $b_{760}$ 198-200°, $d_{20}^{20}$ 0.9540, $n_D^{20}$ 1.5056. Similarly, Pr and iso-Pr alcs. and phenol yielded the corresponding *p*-iso-Pr deriv., $b_{760}$ 213-14°, $d_{20}^{20}$ 1.0157, $n_D^{20}$ 1.5092, and *o*-iso-Pr deriv., crystals, m. 61°. Other compds. prepd. were *p*-*tert*-butylanisole, $b_{760}$ 211-15°, $d_{20}^{20}$ 0.9135, $n_D^{20}$ 1.5000, and *p*-*tert*-butylphenol, crystals, m. 99° (from iso-BuOH), and *p*-*sec*-butylanisole, $b_{760}$ 108-10°, $d_{20}^{20}$ 0.9140, $n_D^{20}$ 1.5050 (from BuOH). H. M. Leicester

Mbr., Lab. Organic Chemistry, Middle Asiatic State Univ., -1944-.

ASM-SLA METALLURGICAL LITERATURE CLASSIFICATION

Ca 10

**Activity of halogen in organic compounds in Friedel-Crafts syntheses. I. Condensation of ethyl esters of aliphatic halogen-substituted acids with benzene.** I. P. Tsukervanik and I. V. Terent'eva. *Doklady Akad. Nauk S.S.S.R.* 50, 257-60(1945).—The position of Cl determines the nature of the products from the Friedel-Crafts reaction of $C_6H_6$ with esters of halo aliphatic acids; the activity of Cl rises with increased distance from the COO group. $C_6H_6$ (100 ml.), 40.5 g. $EtO_2CCH_2Cl$, and 68 g. $AlCl_3$, after standing 24 hrs., boiling 1.5 hrs., and heating 5 hrs. on a steam bath, gave 70% mixed hydrocarbons from which EtPh, a mixt. of isomeric $Et_2C_6H_4$, and 1,2,4-$Et_3C_6H_3$ were isolated; the latter gave 1,2,4-$C_6H_3(CO_2H)_3$, m. 315-18°, after oxidation by $HNO_3$ at 165-70°. $C_6H_6$ (100 ml.), 34 g. $EtO_2CCH_2CH_2Cl$, and 70 g. $AlCl_3$, after 24 hrs.' standing and 6 hrs. at 60°, gave 68% $PhCH_2CH_2CO_2H$ (m. 49°, b. 280°), 7 g. EtPh, and 12 g. $PhCOCH_2CH_2Cl$ (b. 255-65°, $n_D^{20}$ 1.5532, $d_4^{20}$ 1.0860); merely letting the mixt. stand 14 days gave only 74% $PhCH_2CH_2CO_2H$ and EtPh. $C_6H_6$ (50 ml.), 9 g. $EtO_2C(CH_2)_3Cl$, and 20 g. $AlCl_3$ let stand 30 hrs., kept 12 hrs. at 60-70°, and boiled 3 hrs. gave 2 g. EtPh, 4 g. $Ph(CH_2)_3CO_2H$, m. 51°, and 4.5 g. 3,4-dihydro-1(2*H*)-naphthalenone, $b_5$ 132-4°, $n_D^{20}$ 1.5665, $d_4^{20}$ 1.0695. G. M. Kosolapoff

ASM-SLA METALLURGICAL LITERATURE CLASSIFICATION

1ST AND 2ND ORDERS

PROCESSES AND PROPERTIES INDEX

3RD AND 4TH ORDERS

Ca

10

**Thermal splitting of opianic acid.** I. P. Tsukervanik and A. S. Sultanov (Middle-Asiatic State Univ.). *J. Gen. Chem.* (U.S.S.R.) 16, 1715-17(1946).—The reaction was studied as a source of veratraldehyde. Narcotine (tech., 300 g.) was added to 3 l. 5% $H_2SO_4$ heated to 60° and the mixt. heated to gentle boiling and treated slowly with 500 g. $MnO_2$ over 1.5 hrs., with concurrent addn. of 1.5 l. 10% $H_2SO_4$. The mixt. was boiled 5 hrs., treated with a satd. soln. of 25-30 g. $KMnO_4$, boiled 0.5 hr., and treated with 5 g. charcoal. After filtration and cooling 1.5 days, 63% opianic acid, m. 144-5°, was obtained. This was purified by soln. of 50 g. in 120 cc. 20% $NH_4OH$, filtration, and treatment with 40 g. $CaCl_2$; after heating until soln., cooling, clarifying with charcoal, and filtration, pure opianic acid, m. 148°, was obtained on cooling and acidification with 10% HCl; 5 g. subjected to dry distn. gave 3 g. distillate which, after soln. in $C_6H_6$, washing with 5% NaOH, and evapg., gave 7.6% veratraldehyde, isolated as the semicarbazone, m. 175°; repetition of the distn. at 170° and 10-12 mm. gave 4 g. distillate contg. 0.6 g. veratraldehyde and 0.2 g. isovanillin. The results were improved by conducting the pyrolysis in the presence of Cu (Kahlbaum Cu bronze powder) in a small autoclave at 200-10° (20-5 atm. pressure) in benzene soln. The best result was obtained as follows: 50 g. opianic acid, 100 g. Cu, and 130 cc. $C_6H_6$ were heated to 200-10° 5 hrs., after which the mass was continuously extd. with $C_6H_6$ and *veratraldehyde* ($b_{10}$ = 135-42°) was fractionally distd. from the ext. in 60% yield. G. M. K.

Mem., Lab. Organic Chemistry,
Middle Asiatic State Univ.,
-1945-.

ASM-SLA METALLURGICAL LITERATURE CLASSIFICATION

MEL'KANOVITSKAYA, S.G.; TSUKERVANIK, I.P.

Allylation of phenol compounds in the presence of a copper catalyst. Dokl.AN Uz.SSR no.11:40-44 '59. (MIRA 13:4)

1. Institut khimii AN UzSSR. 2. Chlen-korr. AN UzSSR (for Tsykervanik).
(Propene) (Eugenol)

SOV/79-28-8-7/66

AUTHORS: Mel'kanovitskaya, S. G., Tsukervanik, I. P.

TITLE: Radical and Ionic Alkylation of the Aromatic Nucleus (Radikal'noye i ionnoye alkilirovaniye aromaticheskogo yadra ) VII. Butylation of Benzene, Naphthalene, Phenol, and Anisole (VII. Butilirovaniye benzola, naftalina, fenola i anizola)

PERIODICAL: Zhurnal obshchey khimii, 1958, Vol. 28, Nr 8, pp. 2032-2038 (USSR)

ABSTRACT: In connection with a previous paper (Ref 1) this paper attempts to explain the peculiarity of the alkylation of different compounds with n-butyl chloride in the presence of copper. As an example the free radical butylation of anisole was investigated. n-Butylphenyltriazene was used as the source of free butyl radicals. In contrast to the benzylation and the reaction with diphenylchloromethane the butylation with copper proceeds much more difficultly (at 200-250°). In reacting n-butylchloride with benzene, naphthalene, phenol, and anisole the corresponding monobutyl and dibutyl aromatic compounds resulted, and in the case of phenol a butyl ether

Card 1/3

Radical and Ionic Alkylation of the Aromatic Nucleus. SOV/79-28-8-7/66
VII. Butylation of Benzene, Naphthalene, Phenol and Anisole

of the butylphenol also resulted. Side products could not be determined. In every case it was the secondary butyl derivative which was produced. The proof of the structures was carried out by perbrominating and oxidizing. It was found that the alkylation product yield in the above reactions was 38-87 %. Thermal butylation also yielded alkyl derivatives. Under the experimental conditions used an isomerization of the primary butyl group to the secondary form always took place. The butylation of phenol follows the mechanism of indirect nuclear alkylation. Free butyl radicals produced by the thermal decomposition of n-butylphenyltriazene can be used to alkylate the anisole nucleus. There are 4 tables and 25 references, 11 of which are Soviet.

ASSOCIATION: Institut khimii Akademii nauk UzSSR (Institute of Chemistry AS UzSSR)

SUBMITTED: July 12, 1957

Card 2/3

Radical and Ionic Alkylation of the Aromatic Nucleus. SOV/79-28-8-7/66
VII. Butylation of Benzene, Naphthalene, Phenol, and Anisole

Card 3/3

AUTHORS: Tsukervanik, I. P., Belinson, Z. Ya. SOV/79-28-8-8/66

TITLE: Condensations of Benzotrichloride With Benzene in the Presence of Aluminum Chloride (Kondensatsii benzotrikhlorida s benzolom v prisutstvii khloristogo alyuminiya)

PERIODICAL: Zhurnal obshchey khimii, 1958, Vol. 28, Nr 8, pp. 2038-2042(USSR)

ABSTRACT: The authors investigated the condensations of benzotrichloride with benzene in order to produce the various substitutions of the chloride atom and to ascertain the conditions under which triphenylmethane and 9-phenylfluorene form. It was found that the amount of $AlCl_3$ present is a definite factor in this synthesis. Using 0,1 mole $AlCl_3$ (to 1 mole benzotrichloride), and independent of the temperature (15-90°) and the reagent concentration, a yield of 70 % diphenyldichloromethane was obtained with a small side product of triphenylchloromethane. With 1 mole of $AlCl_3$ triphenylchloromethane was produced as the main product with a yield of 80-98 %. Further increases in the amount of $AlCl_3$ caused a hardening reaction and a decrease in the triphenylchloromethane yield. Other factors in this synthesis were studied, among them

Card 1/2